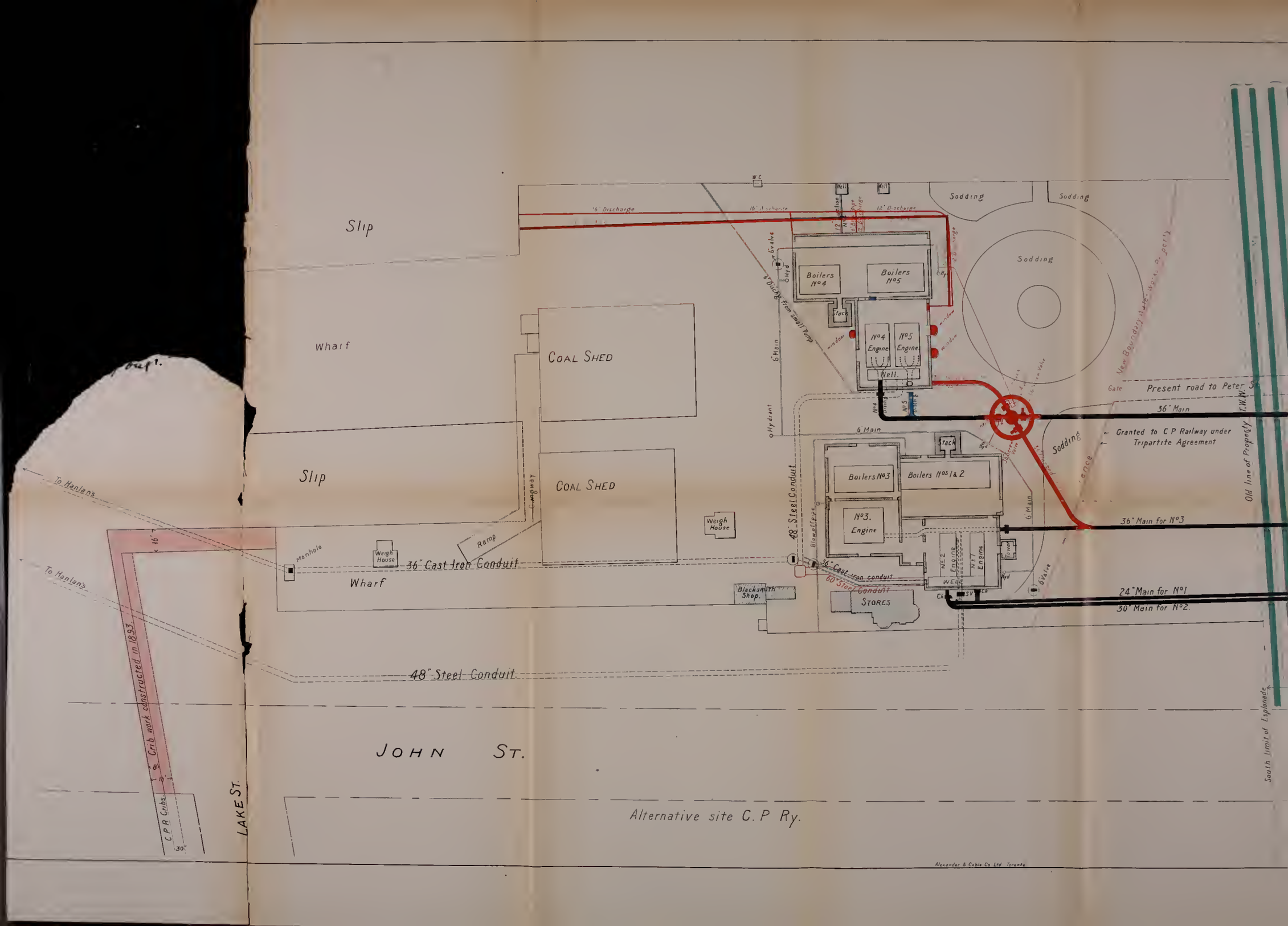

Slip
Wharf
Coal Shed
Slip
Coal Shed
Wharf
Boilers No4
Boilers No5
No4 Engine
No5 Engine
Well.
Stack
Boilers No3
Boilers Nos 1 & 2
No3. Engine
No 2 Engine
No 1 Engine
Weigh House
Weigh House
Blacksmith Shop
Stores
Sodding
Sodding
Sodding
Present road to Peter St.
36" Main
Granted to C P Railway under Tripartite Agreement
36" Main for No3
24" Main for No1
30" Main for No2.
Old line of Property
T.W.W. Co.
48" Steel Conduit
36" Cast Iron Conduit
60" Steel Conduit
36" Cast iron conduit
6" Main
6" Discharge
16" Discharge
12" Discharge
Manhole
Ramp
Gangway
To Hanlans
To Hanlans
Crib work constructed in 1893
C P R Cribs
48" Steel Conduit.
JOHN ST.
LAKE ST.
Alternative site C. P Ry.
South Limit of Esplanade
Alexander & Cable Co Ltd Toronto

T. W. W.

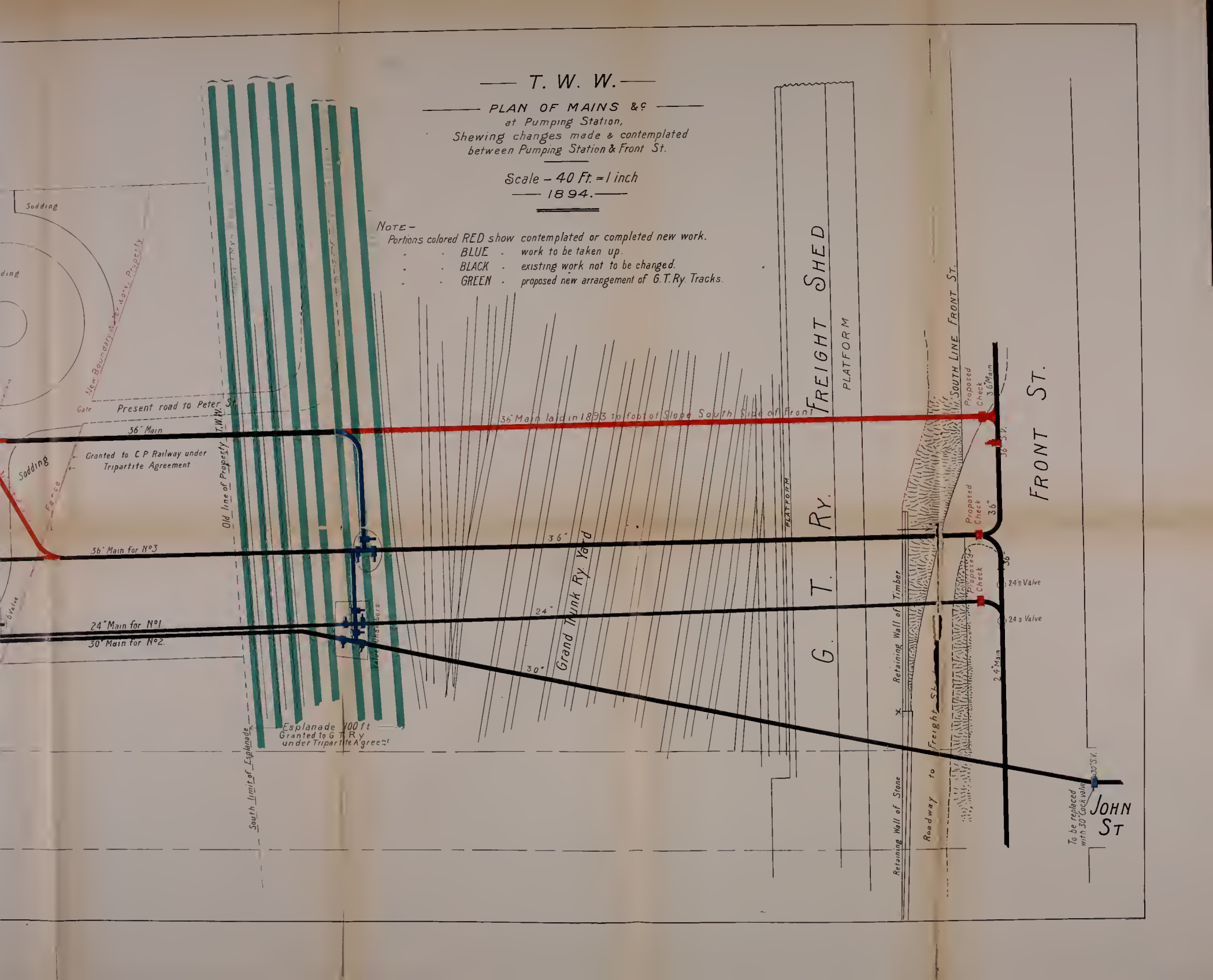
PLAN OF MAINS &c

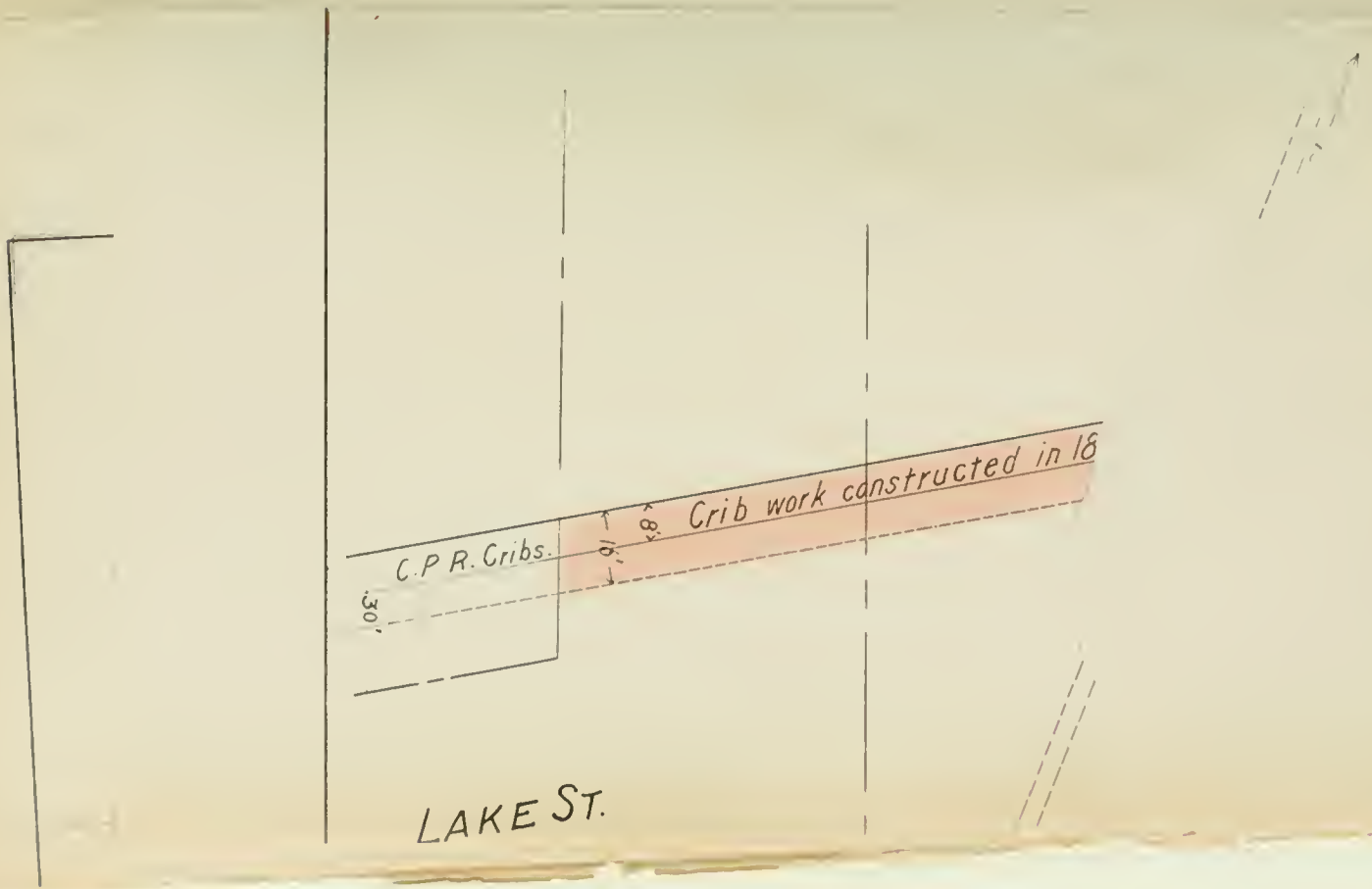
at Pumping Station,
Shewing changes made & contemplated
between Pumping Station & Front St.

Scale – 40 Ft. = 1 inch

1894.

NOTE –
Portions colored RED show contemplated or completed new work.
" " BLUE " work to be taken up.
" " BLACK " existing work not to be changed.
" " GREEN " proposed new arrangement of G.T.Ry. Tracks.




C.P.R. Cribs.
30'
11'-6"
Crib work constructed in 18
LAKE ST.

ANNUAL REPORT

OF THE

CITY ENGINEER

OF

TORONTO

FOR

1893

Toronto:
J. Y. Reid, City Printer, 73 to 81 Adelaide Street West.
1894.

INDEX TO REPORTS

Water Works Department Matters.

Works Department Matters.

INDEX TO REPORTS—*(Continued).*

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Water Works.

Works.

ANNUAL REPORT

OF THE

CITY ENGINEER

TORONTO

FOR THE YEAR 1893.

CITY ENGINEER'S OFFICE,
Toronto, December 31st, 1893.

To His Worship the Mayor and Members of the Council of the Corporation of the City of Toronto:

GENTLEMEN,—In compliance with By-law No. 2534, I beg to lay before you my Annual Report setting forth the various works of construction carried out during the year ending 31st December, 1893, together with details of cost of construction and maintenance.

OFFICIAL STAFF.

The following is a list of the chief officers who compose the official staff in the Works and Water Works Departments:

City Engineer and Chief Engineer of Water Works Dept. ..... Edward H. Keating, M. Inst. C.E., M. Am. Soc. C.E.
Deputy City Engineer ..... Charles H. Rust, M. Can. Soc. C.E.
Engineer in Charge of Sewers and Water Works Construction ..... C. L. Fellowes, C.E.
Engineer in Charge of Roadways ..... H. D. Ellis, D.L.S., O.L.S., Assoc. M. Can. Soc. C.E.
Engineer in Charge of Bridges and Mechanical Engineer Water Works Dept. John Williams, M. Can. Soc. C.E.
Surveyor ..... Villiers Sankey, O.L.S.
Street Commissioner ..... John Jones.

Accountant	Wm. McCartney
Chief Clerk Works Dept.	E. P. Roden.
Secretary Committee on Works	A. H. Clarke.
Secretary City Engineer	G. J. Castle.
Secretary Plumbing Dept.	C. E. Rudge.
Chief Engineer Main Pumping Station	Robt. Pink, M.E.
Chief Engineer High Level Pumping Station	Chas. Heal.
Chief Clerk Water Works Dept.	Chas. A. Matthews.
Foreman of Construction Water Works Dept.	Ed. Foley.
Foreman in Charge Machine Shop, Water Works Dept.	H. J. Orpen.
Foreman in Charge Hydrants, Water Works Dept.	Wm. Black.
Storekeeper Water Works Dept.	Thos. Skippen.

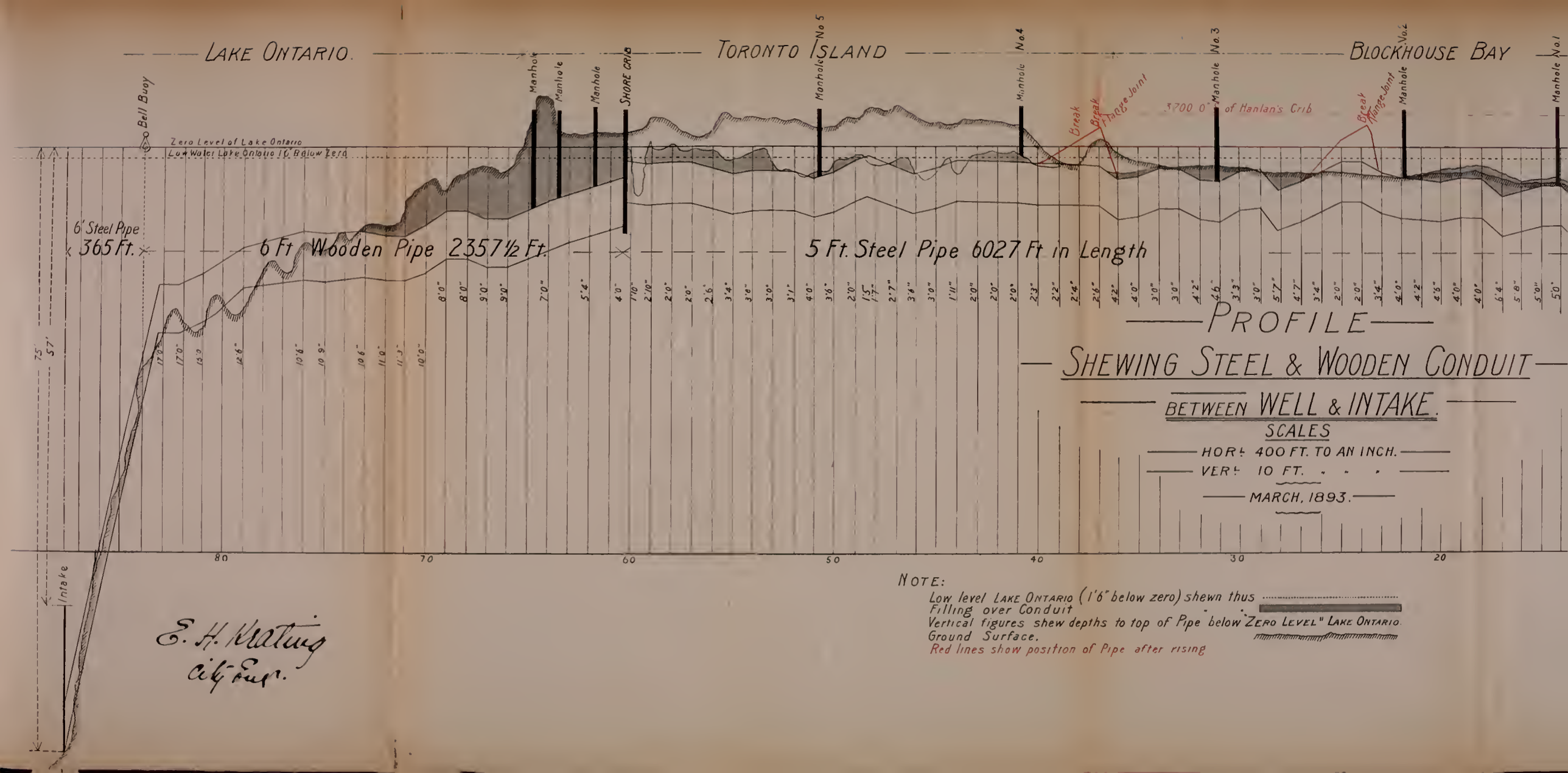
WATER WORKS MATTERS.

FINANCIAL.

The total expenditure for Water Works purposes during the year (exclusive of the revenue collection and inspection branches, and also exclusive of interest and sinking fund on the debenture debt) amounted to $307,170.28, divided as follows:

Net ordinary working expenses		$166,025 92
Construction account:		
Pipe-laying	$40,068 10	
House services	11,817 30	
New engines	55,519 00	
Repairing damaged conduit, including work at Haulan's crib, etc.	31,435 58	
Investigation re new source of supply	2,504 38	
		141,144 36
		$307,170 28

The net total revenue from all sources was $446,734. The net expenditure on maintenance account was $166,025.92, which, with $224,732 for interest on sinking fund, made a total charge of $390,757 92, leaving a surplus of revenue over ordinary working expenses of $55,976.08.



PROFILE

SHEWING STEEL & WOODEN CONDUIT

BETWEEN WELL & INTAKE.

SCALES

HOR: 400 FT. TO AN INCH.

VER: 10 FT. " "

MARCH, 1893.

E. H. Keating
City Engr.

NOTE:

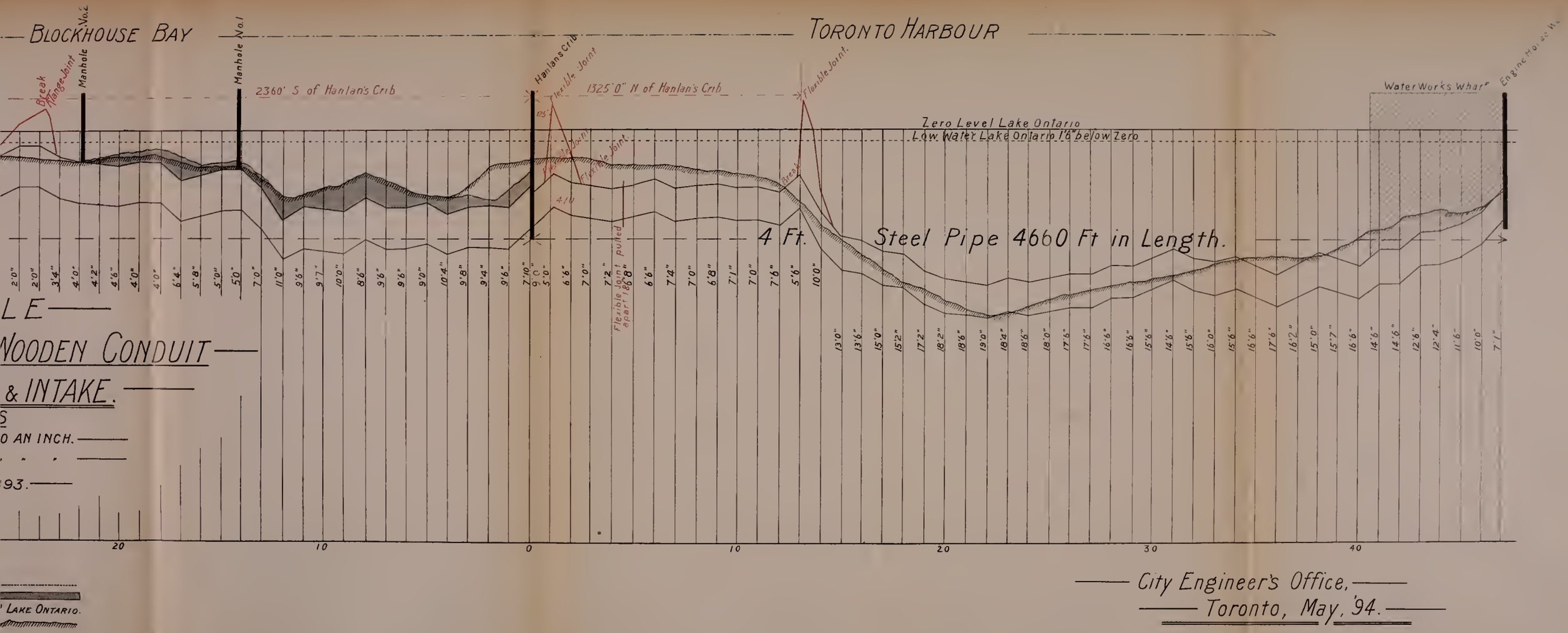
Low level LAKE ONTARIO (1'6" below zero) shewn thus .....

Filling over Conduit

Vertical figures shew depths to top of Pipe below "ZERO LEVEL" LAKE ONTARIO.

Ground Surface.

Red lines show position of Pipe after rising



L E

NOODEN CONDUIT

& INTAKE.

S

O AN INCH.

93.

LAKE ONTARIO.

City Engineer's Office,

Toronto, May, '94.

GENERAL.

On the 30th January, 1893, by special resolution of the City Council, all the works and property under the management of the Water Works Department were placed under the control of the City Engineer, the rating and collection branches of the Department being transferred to the City Treasurer.

Owing to the accident to the conduit—which is referred to in the annual report of the late Superintendent, Mr. Wm. Hamilton, for 1892—the entire water supply of the City, at the time the works were placed under my charge, was being drawn directly from the sewage-polluted waters of Toronto harbor, and as a natural consequence typhoid fever cases and deaths increased to such an alarming extent as not only to cause the greatest anxiety, but to threaten the business prospects of the City.

The accompanying profile shows in red lines the portions of the conduit which rose above the surface of the Bay, and which remained disconnected and embedded in the ice until the necessary repairs could be effected.

I have also indicated on the profile the positions of all the breaks discovered in the conduit, which have since been repaired and are believed now to be perfectly tight.

In addition to the unfortunate condition of the conduit, serious defects were found to exist in the old pumping well and at Hanlan's crib, both of which were leaking badly and admitting large quantities of Bay water with its accompanying impurities.

Both of these structures have since been thoroughly repaired and made absolutely tight.

The old pumping well was repaired by removing all the damaged and broken cast-iron plates with which it was lined, plugging up the voids in the masonry, substituting new plates where required, and adding an additional tier to the top, so as to bring it above the normal level of the Lake and prevent any leakage through the masonry from flowing over the top of the well, which otherwise would have been liable to occur.

Hanlan's crib was repaired and made tight by the insertion of a steel lining, with cast-iron valves both on the inlet and outlets.

The 6-foot steel conduit, from the bell-buoy crib to the deep-water intake, was also found to be seriously defective. This conduit

originally rested on cribs, so that portions of it were elevated to a considerable height above the bottom of the Lake. It was found on examination that the conduit had rolled off these cribs, and lay broken and embedded in the soil in the bottom of the Lake. No connection existed between this conduit and the southern end of the 6-foot wooden conduit at the bell-buoy, and it was found to be almost completely filled with sand, so that it was useless, as no water was being drawn through it.

As soon as possible, after this discovery was made, it was entirely taken up, brought into the City, repaired and replaced, with the addition of two flexible joints and a new vertical bell-mouthed intake at the outer end, projecting seventeen feet above the bottom of the Lake, as will be seen by reference to the attached profile and photograph.

For particulars as to the above works I must refer to the accompanying report of Mr. Williams, the engineer in charge of the repairs, and for the condition of affairs at the Main Pumping Station, I must refer to the report of Mr. Pink, the chief engineer at that station.

The new 10,000,000-gallon pumping-engine (No. 4) has not yet been taken off the hands of the contractors, Messrs. Geo. F. Blake & Co., to whom another contract for an additional 10,000,000-gallon engine (No. 5) has been awarded for the sum of $54,993.00.

A great deal of trouble and annoyance has been experienced by the presence of large quantities of fine sand in the water, which has caused considerable damage to the pumps, water meters and other machinery. The best method of getting rid of this sand is now under consideration.

The provisions of the Tripartite Esplanade Agreement have necessitated the re-arrangement of pipes and other works at and in the vicinity of the Main Pumping Station, involving considerable expenditures, for which no provision was made in the agreement.

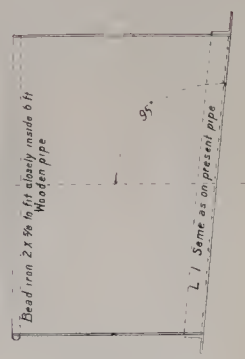
Under this agreement the City also loses about an acre of land from the northern end of the Main Pumping Station grounds, and the dock at which coal was formerly landed, on the eastern side of the station, has been closed and will be filled in.

Access to the Main Pumping Station is now exceedingly awkward and dangerous, by reason of the number of railway tracks which have to be crossed in order to reach it; and as more tracks are about being

TORONTO WATER WORKS

LAKE EXTENSION.

NEW INTAKE & SCREEN.



Sleeve for final connection

Bolt holes in this flange are to correspond in size and number to those in existing flanges

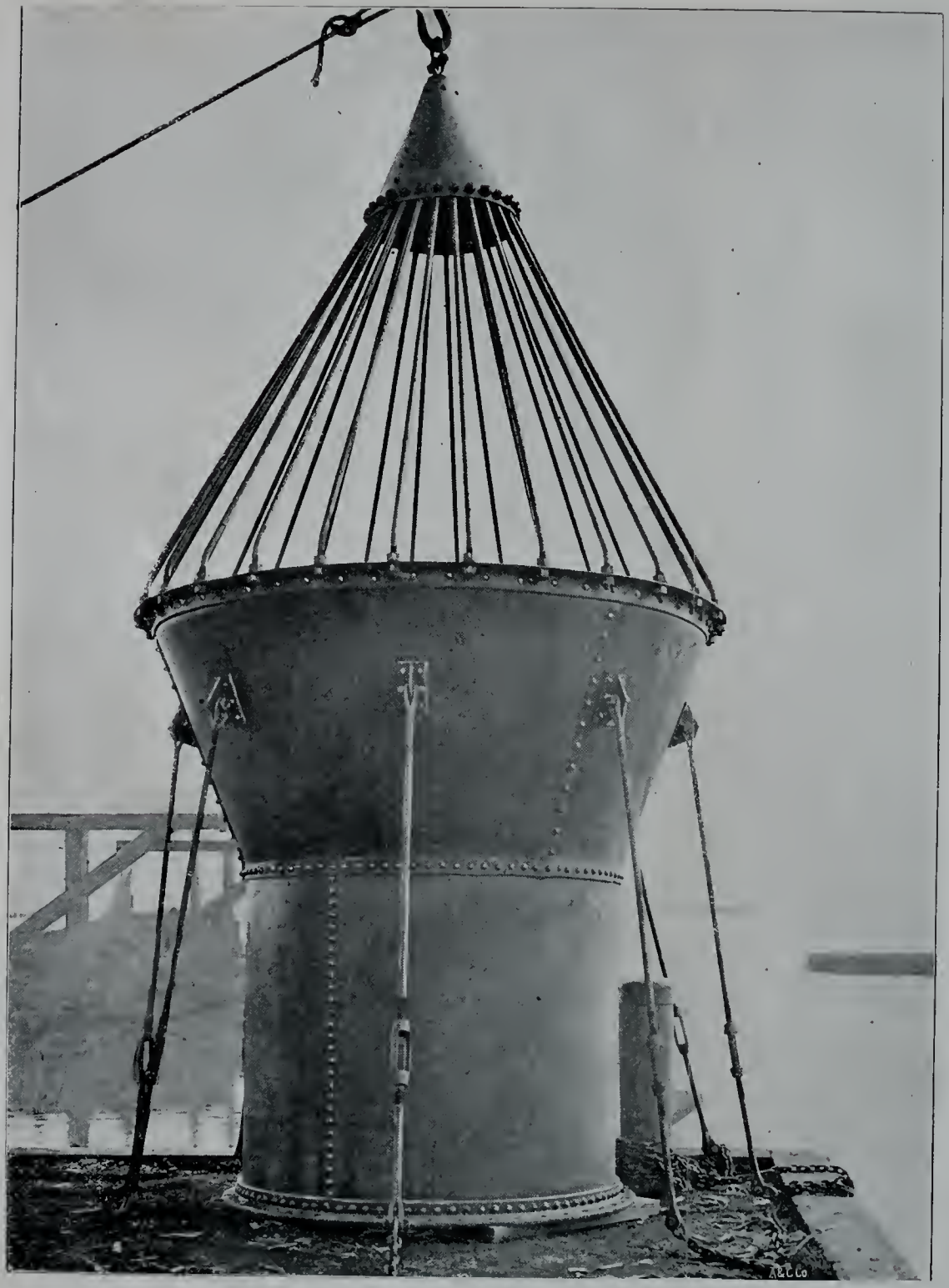
SCALE ½ INCH = 1 FOOT.

E. H. Keating
City Engr.

CITY ENGINEER'S OFFICE
TORONTO JUNE 8-'93.

J. Williams

Alexander & Cable Co. Ltd. Toronto



6 FT. STEEL INTAKE PIPE IN LAKE ONTARIO.
BELL MOUTH AND SCREEN.

laid, both by the Canadian Pacific and Grand Trunk Railways, immediately in front of this important station, access to it will be still more difficult and dangerous until the contemplated bridge at the foot of John Street is constructed. Negotiations for the construction and early completion of this bridge are now in progress with the railway companies concerned.

The condition of affairs at the High Level Pumping Station and at Rose Hill Reservoir may be reported as generally satisfactory, except that at the Reservoir certain repairs and improvements are needed, which are referred to in Mr. Fellowes' report.

During the year the following additions have been made to the distribution system, viz.:

370	lineal feet of	36-inch	mains.
9,000	"	12 "	
14,685	"	6 "	
69	fire hydrants.		
76	valves.		
526	service pipes.		

And the following have been removed, viz.:

2,730	lineal feet of	12-inch	cement mains.
3,622	"	6 "	"
1,583	"	8 "	iron mains.
460	"	6 "	"
263	"	4 "	"
10	fire hydrants.		
8	stop valves.		
5	check valves.		

The total length of water mains now in use is			244.96 miles.
"	number of hydrants	"	2,827
"	" stop valves	"	1,988
"	" check "	"	62
"	" service pipes	"	39,927

Detailed reports from the chief officers of the two departments will be found appended hereto, and also the usual schedules.

At the Main Pumping Station the total quantity of water pumped during the year was 6,646,021,488 imperial gallons. The average daily consumption was 18,208,278 gallons, as against 18,246,371 gallons in 1892. At the High Level Pumping Station the total quantity of water pumped during the year was 899,451,584 imperial

gallons. The average quantity pumped daily was 2,464,250 gallons, as against 3,588,738 gallons in 1892.

For more full particulars I beg to refer to the attached "Summary of Statistics" prepared in accordance with the recommendation of the New England Water Works Association, which is the form now adopted by many of the principal cities in the United States, and which will be found of considerable interest and value, especially for the purposes of easy reference and comparison.

I would also call special attention to my report, dated 30th Oct., 1893 "on the proposed enlargement and improvements in the Toronto Water Works," which I have embodied in the Appendix, not only in order to avoid repetition as far as possible, but that it may be preserved where it may at any time be easily referred to.

In that report it is, among other things, recommended that a new 24 inch main should be laid along Front Street, from Simcoe Street to Sherbourne Street, at an estimated cost of $36,000; that a new 30-inch force main be laid from the intersection of Bathurst and College Streets along Dupont, McPherson and Yonge Streets to Rose Hill Reservoir, at an estimated cost of $135,500; and that a new 12-inch high service main be laid on Avenue Road, from Davenport Road to Bloor Street at an estimated cost of $5,500. These improvements are all needed, and I trust that in the public interests the funds for carrying them out will be voted as soon as practicable. As there seems to have been some misapprehension regarding these works, I might add that they are in no way connected with the proposed tunnel scheme, and are required whether that or any other project should be adopted for increasing the supply of water brought into the City.

In addition to the above improvements, it is highly desirable that steps should be taken to improve the service in the west end, by providing larger mains in Parkdale, in place of the existing 4-inch pipes, which are too small; and in the east end, by making such alterations as are necessary to place that district lying east of the River Don and north of Gerrard Street, in the high service system, instead of allowing it to remain in the low service, which is inadequate to furnish effective fire protection.

WORKS DEPARTMENT MATTERS.

FINANCIAL.

During the year the total expenditure of the Works Department (not including Water Works) was $1,307,409.92, divided as follows:

General appropriation	$351,146 57
Local improvements	186,386 73
Special services	377,846 45
Street railway pavements	392,030 17
	$1,307,409.92

The amount for local improvements was divided as follows:

Sewers	$ 9,899 32
Pavements	102,316 50
Sidewalks	43,127 17
Grading, bridges, etc.	31,043 74
Total	$186,386 73

The number of petitions received by the Department for local improvement works during the year was 58. The number of local improvements recommended was 266, made up as follows:

Sewers	13
Roadways	54
Sidewalks	198
Street extensions	1

Of the sidewalks recommended, 2 were for concrete, and the remainder for wood.

The principal work that has engaged the attention of the Department during the past year has been the conversion of the Street Railway tracks and pavements. Owing to the dispute arising between the Toronto Railway Company and the City as to the meaning of the terms "permanent pavement" and "permanently formed roadway," in the agreement between the Company and the City, the work of conversion was seriously delayed and was not commenced until August. This delay necessitated the pushing on of the work with more than ordinary vigor during the remainder of the working season, and the completion of some of the pavements later in the year than is generally considered desirable. The length of track laid during the year was 33.8 miles.

ASHBRIDGE'S BAY.

In the matter of improving the sanitary condition of Ashbridge's Bay, contracts were awarded early in the Spring, the work being divided into two sections: No. 1 embracing the dredging, excavation and formation of a channel, 80 feet in width at the bottom, from Toronto Bay eastwardly through the Government Breakwater and Marsh, to the open water near Leslie Street, covering a total length of 9,300 feet. This contract was awarded to F. B. McNamee for the sum of $62,102. Work was commenced on this section in July, and at the close of the season the channel had been partially opened up from a point 1,500 feet west of the Government Breakwater eastwardly about 4,100 feet. From Leslie Street westwardly a channel was also dredged for a distance of about 1,300 feet and to an average depth of about 6 feet.

No. 2 section called for the excavation, dredging and formation of a channel, 80 feet in width at the bottom, through the sandbar dividing Lake Ontario from Ashbridge's Bay, and also the construction of a jetty on the east side of the channel. This contract was awarded to John Shields, for the sum of $44,964, and up to the end of the year the contractor had opened up the channel, though not to its full width, and had also made some progress on the jetty.

The jetty is to consist of three rows of piles, placed 8 feet apart between centres, both transversely and longitudinally, mattresses of brush and small trees, a hearting of small stones, weighing about 100 lbs. each, and the slopes of large stones weighing from 3,000 to 4,000 lbs. Two hundred and fifty feet of this jetty have been completed, and 303 piles were driven, or to the full length of the work, besides which the stone hearting has been put in for a distance of 800 feet, and a quantity of large stone has been put in place. The total amount of stone of all kinds put in this work up to the end of the year was 8,900 cubic feet. In addition to this the mattresses have been placed and sunk in position on both sides of the jetty.

In August it was decided to construct a jetty on the west side of the above channel, and in September the contract therefor was awarded to R. Grant, for the sum of $15,000. The contract called for the construction of a jetty somewhat similar to the eastern one, with the exception that no piling is required; the total length of the jetty is to be 430 feet, and no hearting of small stones is to be used, the

specifications calling for large stones of not less than 3,000 lbs. in weight. Up to the end of the year stone has been placed in this jetty up to the zero water-level to a distance of 100 feet from the northern end to an average width of 24 feet. Mattresses have been placed under the entire length of this work.

I trust that the whole of these works will be completed by the close of the working season of 1894. Until these jetties are extended further southwardly into Lake Ontario it is possible that occasional dredging operations in the channel may be required.

SEWERS.

During the year 3.32 miles of sewers were constructed, of which 1.10 miles were built by day labor. The total expense of this work was $45,997.79, making a total of 225.07 miles of sewers of various sizes within the City limits. During the year 90 miles of sewers have been flushed and cleaned, at a cost of about $59.65 per mile. A sewer on Queen Street East, for the carrying off of storm water to relieve this district, has been constructed, and I trust that now this sewer is built it will do away with the constant flooding of cellars in this section of the City after heavy rain storms. A sewer on Queen Street West, from Bathurst Street to the Garrison Creek, was also constructed for the same purpose. All the sewers emptying into Ashbridge's Bay have been extended southerly towards the line of the proposed channel. Parliament Street sewer has been extended to deep water. Both the Simcoe and Bathurst Street sewers have been re-constructed where they cross under the railway tracks on the Esplanade.

During the year $3,098.24 was expended in the dredging of deposits at the mouths of the various sewers emptying into the Bay.

PRIVATE DRAINS.

Five hundred and sixty-three private drains have been constructed by the Department during the year, measuring 2.69 miles. The total amount received for this service was $11,266.84, and the expenditure was $12,064.68. Owing to the decrease in the number of private drains constructed, the services of two of the permanent Inspectors have been dispensed with.

PLUMBING INSPECTIONS.

The number of inspections made for plumbing, drainage and smoke tests was 14,605 as compared with 15,409 in 1892.

A special report of this branch of the Department is appended hereto.

ROADWAY CONSTRUCTION.

The following is a summary of new pavements and work done in the roadway branch of this Department. The total length of new pavement laid during the past year was 18.72 miles. The increased mileage laid during the year was composed largely of permanent pavements laid in connection with the change in the street car rails.

Classes of Pavements laid in 1893.

(Including Pavements on Track Allowances.)

Asphalt	5.60 miles.
Cedar block on sand or plank foundations	3.24 "
Cedar block on concrete	2.18 "
Stone setts on concrete	3.74 "
Bricks on concrete	3.96 "
Concrete sidewalks	2.25 "

Attached to the report of the Roadway Engineer will be found a table which I think will prove of interest to the ratepayers, as it gives the cost per square yard of different classes of pavement and also the cost per foot frontage. There were 45 contracts let and 11 remained over from last year, making a total of 56, of which 51 have been completed, leaving 5 to be carried out during the coming year.

A number of tables will be found attached, giving full information regarding the operations of the Department, and also tables giving the results of a series of tests of different classes of materials and bricks used during the year.

SURVEY DEPARTMENT.

In addition to the regular routine work done in connection with this Department, the following are some of the more important matters which have been undertaken:

The completion of arrangements under the Esplanade Agreement, the Windmill Line extension and a number of arbitrations in connection with claims. In the Esplanade Agreement, Mr. ex-Ald. Defoe was appointed by the Council to assist the City Surveyor in dealing

with the real estate claims, the settlements being rather complicated. Under the Esplanade Agreement, parts of Esplanade, Simcoe, John and Peter streets were closed by By-law and given to the G. T. R., that corporation having acquired the necessary land on Front Street for the new Union Station building. The south train shed is now in course of completion and work on the main building is well under way. The only important matters in connection with this agreement yet to be carried out are the construction of the York and John Street bridges and the handing over of the alternative site to the C. P. R.; but owing to certain differences as to the interpretation of the agreement, this transfer has not yet been carried out, and the details regarding the required bridges have yet to be arranged.

WINDMILL LINE AGREEMENT.

In connection with this agreement, the clerical work is now completed, and the patents to the City have been issued under authority of an Order-in-Council. Under the provisions of this agreement the southerly limit of the water lots, which was known as the Windmill Line, has been removed southwardly into the bay a distance of 644 feet, between Princess and York Streets, running back to and joining the old Windmill Line on Parliament and Brock Streets. By this extension it is now possible to carry all the City wharves into deep water. For the filling in and construction of Lake Street, which runs from John to Parliament Street, a limit of 15 years is allowed in the agreement, and for the filling in of the prolongation of the present streets a limit of 10 years.

DON IMPROVEMENT.

A complete survey has been made and plan prepared showing the lands taken and all the buildings adjacent thereto. This work is now in such a condition that the assessment for the cost of the improvement upon the adjoining property may be proceeded with at once.

BRIDGES.

The only work of any importance in connection with the Bridge Department was the building of a new steel bridge, with wooden approaches, at the Western Cattle Market, and strengthening the Queen Street bridge over the River Don. The bridge at the Cattle Market was built for the purpose of conveying cattle from the old

market across the railway tracks to the new addition recently built. The contract for this bridge was awarded to the G. & J. Brown Mfg. Co., of Belleville. The work was commenced in the beginning of May and completed in September. This bridge consists of two lattice girder spans, one of 100 feet and one of 60 feet span, supported on steel columns on masonry foundations.

QUEEN STREET BRIDGE OVER THE DON.

In January, 1893, a contract was entered into with the Hamilton Bridge Company to strengthen this bridge. This strengthening consisted virtually of adding a bowstring bridge complete in every respect, with a new set of floor girders to the old bridge. The work was finished in April.

STREET COMMISSIONER'S DEPARTMENT.

The Street Commissioner, in his report, calls attention to the large number of roadways which were laid with cedar blocks some nine or ten years ago, and which are now entirely worn out. It becomes an important question to determine the best course to be taken for the improvement of these pavements. So far all recommendations to have them re-paved on the initiative system have been opposed, petitioned against and proved unsuccessful. The Street Commissioner suggests that the blocks should be entirely removed from the most dangerous of these streets. This would perhaps protect the City from actions for damages, and might in a measure have the effect of inducing the property owners to interest themselves towards getting a new pavement. These streets do not seem to have worn out with traffic, but in most cases the wooden blocks have simply decayed.

MACADAM ROADWAYS.

Owing to the refusal of the Council to sanction the purchase of a steam road-roller and a stone-crusher, the Department has been seriously handicapped, and has not been able to keep these roads in as good condition as might otherwise have been the case.

A considerable quantity of lake gravel has been used for top-dressing macadam streets in the residential sections of the City.

This Department has also had to do a great deal of work in connection with the change in the street railway system in re-construct-

ing and repairing the pavements outside the rails to meet the changes of grade. Stone setts on concrete foundations were laid by day work on George and Frederick Streets, from King to Front Street, at an average cost of $3.67 per square yard. This includes the cost of the stone setts and the work of re-dressing the same from seven inches to five inches, to correspond to the new rail.

SCAVENGERING.

The total expenditure in this branch of the Department was $58,324.23. The most important matter in connection with this work was the experiment of having ashes and garbage removed by electric cars. Six cars were constructed, the trucks being supplied by the Toronto Railway Company, the cars having a capacity of 13 cubic yards each. The material was carried away after traffic had ceased at night. As the Council did not see fit to adopt this scheme permanently the work had to be discontinued, although the Street Commissioner expresses himself as satisfied that a very large saving could have been effected. To remove garbage, as at present handled, from the west end of the City to Booth Avenue, on a basis of 30 cart-loads, which equal about 3 car-loads, the cost is $30.75, and the cost to remove the same by electric motors was $21.15. For further details in this matter, I would refer to the Street Commissioner's report, as he goes fully into the subject.

The total number of loads collected throughout the City during the year was 80,106. Of these, 9,662 loads were consumed at the eastern crematory. The new crematory erected this year for the western section of the City will be of great advantage in connection with this service. Since operations were commenced in October, the number of loads consumed at the latter crematory was 1,424.

STREET WATERING.

Owing to the large amount of re-construction and pavement work in connection with the street railway during the past summer, this service was somewhat crippled. In accordance with instructions issued to the Street Commissioner, the watering on Yonge and King Street asphalt pavements was confined entirely to the track allowances. Since last year the greater number of the City's watering carts have been fitted with side-valve sprinklers. One of the advantages these sprinklers have is a considerable saving effected in the quantity of water. The

total quantity of water used in this service was 5,922,500 gallons, representing 135,930 loads.

WESTERN STABLES.

I would call special attention to the Street Commissioner's report on the dilapidated condition of the frame structures which are now used as stables in the western section of the City. It is highly advisable that these old buildings should be pulled down and brick buildings substituted, suitable for the large number of horses and the plant owned by the City which have to be cared for at the western yard.

WOODEN SIDEWALKS.

The total mileage constructed during the year was 19.67, for which 969,243 feet, b. m., of lumber was used, and 27,721 lbs. of nails.

SNOW CLEANING.

During the winter of 1892-93, 299 miles of sidewalk were cleaned of snow, at a cost of $7,737.92, being at the rate of one-half cent per lineal foot for each cleaning. This work is charged as a local improvement against the property.

STREET CLEANING.

Since May last the asphalt pavements have been cleaned by the patrol or orderly system. While this is a little more expensive, it is in every way the most satisfactory. The number of miles of streets cleaned during the year was 1,302, from which 155,988 loads of sweepings were removed. The amount expended on this service was $70,148.72.

Respectfully submitted.

E. H. KEATING,
City Engineer.

SUMMARY OF STATISTICS.

TORONTO, ONT., WATER WORKS.

Population, 188,904 (Special Police Census, 1893).
Date of construction, 1872-7.
By whom owned, City of Toronto.
Source of supply, Lake Ontario.
Mode of supply, pumping.

PUMPING.

1. Builders of machinery :
   4,000,000 and 8,000,000-gallon engines, low duty, H. R. Worthington.
   8,000,000 (Martin), Inglis & Hunter.
   10,000,000, Geo. F. Blake Mfg. Co.
   10,000,000 (now building), Geo. F. Blake Mfg. Co.
   At high level station, two engines of 3,000,000 gallons daily capacity each. Geo. F. Blake Mfg. Co.
2. Description of coal :
   (*a*) Good, merchantable anthracite.
   (*b*) Large egg.
   (*c*) Pittston, Scranton, Lehigh, Lackawanna, Wilkesbarre, or other equally good.
   (*d*) Price per ton, $4.19 delivered on dock or in coal-shed.
   (*e*) Wood : Price per cord, slabs, $3.
3. Coal consumed for year, 26,013,840 pounds.
4. Pounds of wood consumed = coal in pounds, 19,911 pounds.
5. Total fuel consumed for year, 26,033,751 pounds.
6. Total pumpage per year, allowance of 2 to 5 per cent. being made for slip. 6,646,021,488 imperial gallons net.
7. Average static head against which pumps worked, 214.
8. Average dynamic head against which pumped, 219.78 feet.
9. Average number of gallons pumped per pound of coal, 255.479.
10. Duty (no deductions made for starting or banking fires, heating building or any other purpose), 56,106,498 foot pounds.

Cost of Main Pumping Station,	$109,582 56
" High Level "	8,481 62
Total,	$118,064 18

11. Per million gallons raised against dynamic head direct (surplus going into Reservoir), $17.76.
11*a*. Cost per million gallons raised against dynamic head direct (surplus going into Reservoir), Main Pumping Station only, $16.48.
12. Per million gallons raised one foot high (dynamic), $.080808.
    Cost of pumping, figured on total maintenance, viz., $390,757.92.
12*a*. Cost per million gallons raised one foot high (dynamic), Main Pumping Station only, $.07498.
13. Per million gallons raised against dynamic head into mains direct (surplus going into Reservoir), $58.79.
14. Per million gallons raised one foot high (dynamic), $.2674.

FINANCIAL.

Receipts.	$ c.	$ c.
Division 1.		
From consumers :		
Water rates, domestic		361,395 82
" manufacturing		
Net receipts for water		361,395 82
Miscellaneous (rents, repairs, sales, etc.)	7,493 33	
Cr. for coal carried over to 1894	8,691 53	
		16,184 86
Total		377,580 68
From public funds :		
Hydrants (including first cost of hydrants and repairs to same)	55,600 00	
Street watering	25,000 00	
Public buildings	3,599 18	
General	1,139 00	
		85,338 18
Gross receipts from all sources		462,918 86

Expenditures.	$ c.	$ c.
Management and repairs (including Dr. of $15,514.38 for coal in stock, 1st January, 1893)		182,210 78
Interest on bonds	188,965 00	
Sinking fund on bonds	33,767 00	
Commission "	2,000 00	
		224,732 00
Total maintenance for year		406,942 78
Balance carried to general funds of City		55,976 08
		462,918 86

CONSTRUCTION.

RECEIPTS.	$ c.	$ c.
Appropriations from general City funds		144,793 86
From other sources		6,958 57
Total		151,752 43
EXPENDITURES.		
Extension and renewal of mains		40,068 10
" " services		11,817 30
Specials :		
Reconstruction of conduit and intake pipe	31,435 58	
New pumping engines	55,319 00	
Investigation *re* new source of supply	2,504 38	
		89,258 96
Balance		10,608 07
		151,752 43

CONSUMPTION.

1. Estimated Population (Special Police Census), 188,904.
2. " " on lines of pipe, 185,000.
3. " " supplied at date, 185,000.
4. Total number gallons consumed for year, 6,616,413,007.
5. Passed through domestic meters, 612,827,025 gallons, or 9.26 per cent.
6. " manufacturing meters, 88,471,188 gallons, or 1.33 per cent.
7. Average daily consumption, 18,127,158.
8. Gallons per day to each inhabitant, 95.95 imperial gallons.
9. " " consumer, 97.984.
10. " " tap (distribution 22), 454 gallons.

DISTRIBUTION.

MAINS.

1. Kind of pipe used, cast-iron.
2. Sizes, from 3-inch to 36-inch.
3. Extensions during year, 14,685 feet.
4. Discontinued during year, 8,668 feet.
5. Total now in use, 244.964 miles.

7. Cost of repairs per mile (including services), $68.61.

8. Small distribution pipes, less than 4 inch, total length,

9. Hydrants added, 69.

10. Hydrants now in use, 2,827.

11. Stop-gates added, 76.

12. Number of stop-gates now in use, 1,988.

15. Range of pressure on mains at centre for day and night, 60 to 80 lbs.
" " " low level district " 30 to 80 "
" " " high level district " 20 to 80 "

SERVICES.

17. Sizes, ¾-inch to 6-inch.

21. Service pipes added during year, 526.

22. Number now in use, 39,927.

23. Average length of service, 33 feet.

26. Meters now in use, owned by City, 1,408.
" " " consumer, 102.
Indicators on hoists, 90.

CHAS. A. MATTHEWS,
Chief Clerk Water Works Dept.

1st January, 1894.

WATER WORKS DEPARTMENT.

REPORT OF ASSISTANT ENGINEER IN CHARGE.

E. H. KEATING, ESQ.,
City Engineer, Toronto:

DEAR SIR,—I beg to submit the following report of this branch of the Department of Works, placed under my charge by you (in a letter dated 1st June, 1893), comprising the general supervision of all civil engineering works, mains, valves, hydrants, services, stores, reservoirs, distribution and water supply.

DISTRIBUTION.

There has been added to the distribution mileage this year 370 feet of 36-inch pumping main, 9,000 feet of 12-inch, 14,685 feet of 6-inch mains, together with 25 12-inch stop valves, 2 9-inch stop valves, 48 6-inch stop valves, and 1 8-inch stop valve, and 69 hydrants; and there has been taken up:

2,730 feet of 12-inch cement main.
1,583 " 8 " old main.
3,622 " 6 " cement main.
460 " 6 " old main.
263 " 4 " "
10 hydrants, 8 stop valves, and 5 check valves.

Leaving a total mileage in the streets of 244,964 mains, 1,988 stop valves, 62 check valves, and 2,827 hydrants. Particulars as to location, sizes, etc., will be found in Schedules appended hereto.

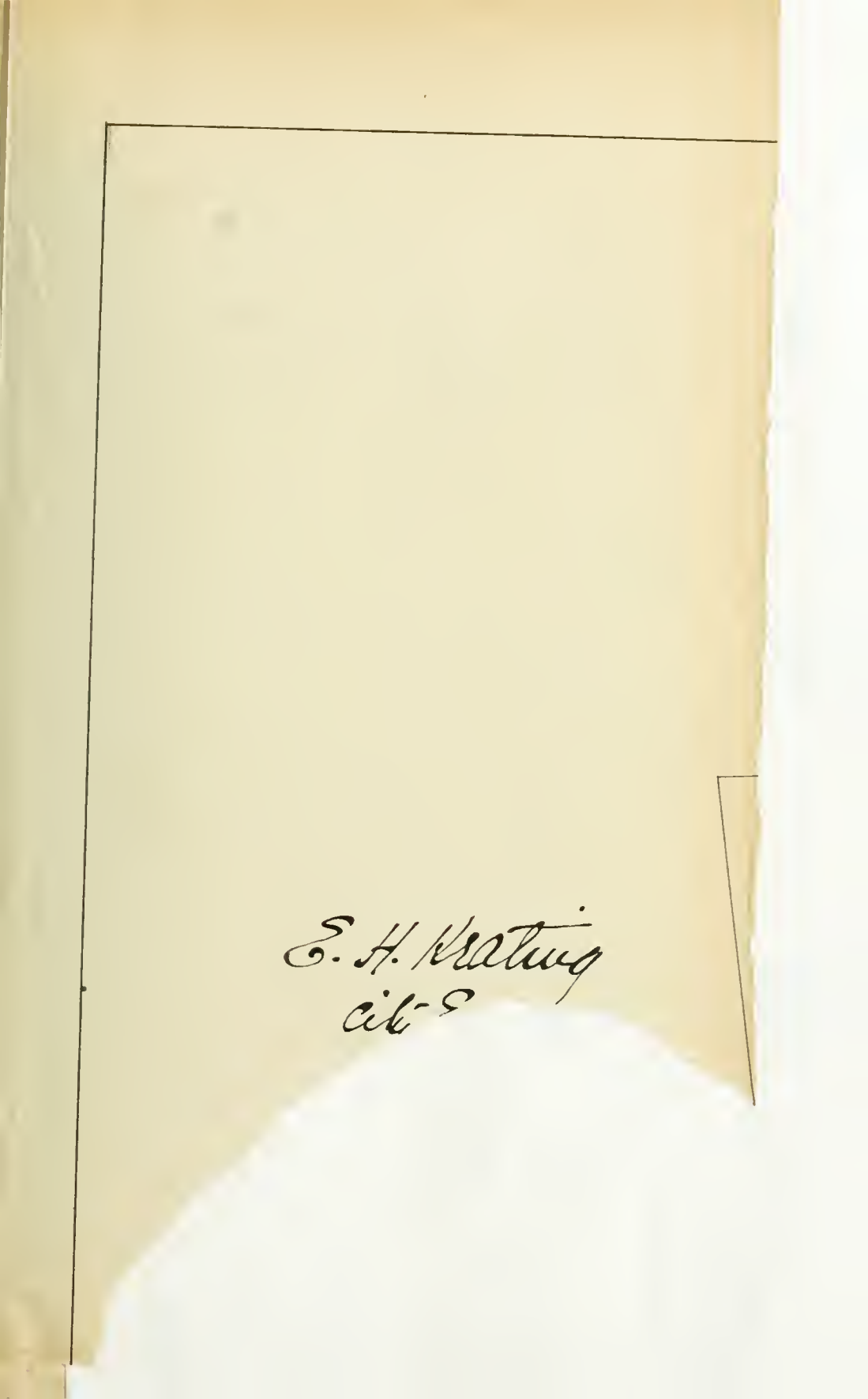
Considerable trouble has been caused by the unavoidable presence of sand in the pipes. The old 8-inch main on York Street, which was this year replaced by a new one, was found three-fourths full of sand. As your report of the 30th October last deals with the necessary additions to mains, etc., to improve the circulation and provide an equable pressure for fire purposes, it is unnecessary for me to refer thereto. There are, however, some minor improvements necessary

The 4-inch mains in Parkdale should be replaced as soon as possible with 6-inch mains, to provide adequate fire protection. The northern portion of the district east of the Don is also in want of more pressure, and should if possible, be connected with the high-level service, as its elevation above the lake renders it impossible to provide a fire pressure from the low-level district with which it is connected.

ALTERATIONS AT MAIN PUMPING STATION.

The appended plan shows the proposed alterations to the pumping mains and connections therewith in red. From the original plan, shown in black, it will be seen that an accident to the 36-inch main from Nos. 4 and 5 engines, between the pumping station and Front Street, would throw both engines out of work until it was repaired; in addition to which the discharge from No. 5 would be entering the 36-inch main from No. 4 at right-angles to the flow of water from that engine, and would doubtless affect the economic working of same. As it is intended, as soon as No. 5 is finished, to use Nos. 4 and 5 for pumping the entire supply for the City, holding Nos. 1, 2 and 3 as reserves in case of stoppage of either engine from any cause, it was considered advisable to alter the discharge of No 5 from the east side of the pumping station to the north side of same, and extend it to a junction with the 36-inch main from No. 4, at a point about 60 feet from the engine-house. This is to be effected by placing a 4-way special branch, constructed of steel, with cast-iron mouths or nozzles, in the centre of a 26-inch diameter circular brick chamber, now under construction (on the line of the 36-inch main from No. 4), the two mains entering the 4-way at an angle of 60 degrees, as shown on plan. On the south side of the 4-way, check valves with by-passes are to be placed, and on the north side two 36-inch screw valves. A 36-inch flange pipe connection is to be made between the 4-way and the 36-inch pumping main from No. 3 engine, thus providing two 36-inch mains into which either one or both engines may pump.

Nos. 1, 2 and 3 engines have force mains of 24, 30 and 36 inches respectively, the engines having a capacity of about 20,000,000 gallons per day. Nos. 4 and 5 have a capacity of about 21,000,000, and under the old plan would have to force this quantity through one 36-inch main.


E. H. Keating
del. &

These mains pass under the tracks of the Grand Trunk and Canadian Pacific Railways, as well as under the Grand Trunk freight shed. An accident to any of them between Front Street and the pumping station might cause a large amount of damage (and consequent expense to the City) before the screw valves could be closed, and might also interfere with the supply. To prevent this it is proposed to put in check valves at the south side of Front Street on each of them, so that the only loss of water will be that lying in the pipes between the level of Front Street and the Esplanade, practically protecting the City from loss of water or any claims for damage in case of a break in any of the mains south of Front Street.

ENGINE-HOUSE FOR Nos. 4 AND 5 ENGINES.

To enable a concrete floor to be laid in the basement of the engine-house for Nos. 4 and 5 engines, and also to build the foundations for No. 5, it was found necessary to carry a puddle wall down to the rock round the entire building, to shut out the large quantity of water that was coming in through the foundation walls. A large quantity of material was also taken out to bring the floor to a level and provide room for the air-pumps and pipes of No. 5 engine.

A tile pipe has been carried round the building to take the rain-water from the roof, which formerly found its way into the basement. Three windows have also been put in, two on the north side and one on the south of the engine-room, to give light and air to the basement. The door that stood about the centre of the engine-room on the north side is to be closed, a new one having been made by cutting down the westerly window of the engine-room on the north side and putting in a sill, etc.

The extension of the 36-inch pumping main for No. 4 engine has been laid under the tracks of the Grand Trunk Railway, from the old valve chamber on Esplanade Street to the foot of the bank at the south side of Front Street, and will be connected with the 36-inch main on Front Street as soon as the necessary pipes, etc., are on hand.

The roads leading to the coal-sheds and engine-houses have had a foundation of large stone given them to prevent their rutting up in spring and during wet weather.

The Tripartite Agreement has necessitated a large amount of work, and has very materially reduced the area of the main pumping

station grounds. Should the Grand Trunk and Canadian Pacific Railways alter their running tracks to their proposed new position before the John Street bridge is ready for traffic, the entrance to the pumping station grounds will be completely closed, as the Grand Trunk Railway's running tracks are to occupy the present roadway.

CRIBBING AT SOUTH SIDE OF LAKE STREET.

The extension of the cribbing for the protection of Lake Street, from the east side of John Street to a junction with the Water Works dock, as provided for in the Tripartite Agreement, has been completed. The effect of this has been to take away from the Water Works property about 350 feet of wharfage at which coal for the engines was formerly discharged from vessels. Should, however, the proposal to place the easterly coal-shed south of the westerly one be carried out, the loss of this dockage will not be felt. The slip, however, will require to be dredged out to provide depth for laden coal vessels.

STORE-HOUSE.

This department is in good order, and supplied with necessary materials required for maintenance of mains, services, meters and engine-houses. All materials required for the departments, whether under contract or otherwise, are obtained by orders through the Storekeeper, and all accounts checked by them and certified to by the Storekeeper before being passed. The stock on hand at the end of the year has been checked over and found to agree with the balances shown in stock-book. This was done by a competent man, not an official of the Department.

The blacksmith shop has been kept busy, and a large quantity of material prepared and work done for all departments of Water Works.

STABLES.

There are 7 horses kept in the stables of the Department, 4 at the test-house and 3 at Lombard Street. Six of these are the property of the City, the seventh being owned by Mr. Foley and in constant use by him, the City providing feed for it. The cost of feed alone has been 30 cents a day for each horse. The cost of feed alone for 1,700 horses of the Street Railway under the Smith, Kiely franchise was 25 cents a day each; so that, considering the small number kept

by the Water Works Department, the cost is not excessive. The wages of drivers and foreman, 5 in all, amount to $2,418 a year. All of the above have been kept constantly employed. Some repairs are urgently needed to the stable at the test-house. The roof should be re-covered, as it leaks so badly the hay is kept damp and musty, and at times unfit food for the horses; the wood work is also being affected by it.

LOMBARD STREET.

This branch of the service is giving satisfaction. It is really an emergency station, a horse, wagon and two men being kept in constant readiness day and night to answer all calls for bursts, whether in mains or services.

All new services, alteration to mains, valves and hydrants are attended to from this place.

In view of the above, I would venture to suggest that a gauge should be kept at this place. There being two men on duty day and night, any sudden fall in pressure could be noted by them, and some time saved by being prepared to answer the call locating the trouble.

RESERVOIR.

The appended Schedule 5 gives the average height of water above zero, the depth and average quantity for each month in the Reservoir. The gauge steps, by which the height of water is ascertained, require re-setting to enable accurate measurements to be taken. The screen over the inlet is in such bad condition that it may fail at any moment, and should be immediately replaced with a new one. While doing this it would be well to concrete the bottom of the Reservoir in the immediate vicinity of the inlet, to enable the deposit that yearly collects there to be easily removed. The amount provided for stone steps on the south side of Reservoir was totally inadequate for that purpose. The cost of suitable stone steps would be from $1,200 to $1,500.

To provide proper drainage for the north end of the Reservoir, and carry off the water from Rosehill Avenue, it became necessary to construct a 2-foot circular brick drain 234 feet long down the road at north side of Reservoir to the creek running through the park. This has been done at a cost of $810.

The grounds are in good condition, and have been largely used by the public, as many as 10,000 people having been counted in them in one day.

This year the City has acquired by grant from Dr. Larratt Smith, under certain conditions, all that portion of the ground enclosed by the banks of the ravine, lying between the south boundary of the Reservoir Park and the road across the ravine from Shaftesbury Avenue. In accordance with the conditions, a fence has been constructed on the line between Smith's property and that granted to the City, and possession of the property acquired.

In order to make this desirable acquisition available to the public a small expenditure will be necessary for cleaning up, underbrushing, trimming, paths, etc.

If the right-of-way through Miss Price's property can be obtained for the Rosedale Ravine Drive, the park will make a charming termination to it; and by a small expenditure of money on the road at the north end of the park, connection could be made between Rosedale Drive and Yonge Street, enabling vehicles to drive from the Don at King or Winchester Streets, through Riverdale Park, east of the Don Rosedale Drive and Reservoir Park to a connection with Yonge Street, forming one of the prettiest drives to be found in this vicinity.

GENERAL.

In connection with your report of the 30th October last, borings were made at the Water Works dock and at Hanlan's, to ascertain whether rock was to be found at Hanlan's, and the nature of it. At the pumping station rock was found at a depth of 9 feet below water level, and at Hanlan's at a depth of 55 feet below the surface. These borings were carried down to a depth of 135 feet each, the rock showing very few water-bearing seams. It is a solid, compact shale rock, and is stated, by men employed in boring for gas at Mimico, to have a depth of about 500 feet, underlying which is limestone rock.

Numerous test-holes were also dug along the western shore of Toronto Island, to ascertain the possibility of laying a pipe dry, and what difficulty would be experienced in keeping water out of the trench. A careful and accurate survey of the western portion of the Island, with soundings out into lake, has been made, and the work

connected by triangulation with the Queen's Wharf and Water Works dock.

The position and depth at which the 4 and 5-foot conduits were after the accident of 25th December, 1892, was obtained, and their position again ascertained after being repaired and lowered. The subjoined profile will show the present depths from zero level to the tops of the 4, 5 and 6-foot pipes between the well and intake.

At times, when the 3-foot pipe across the Bay is shut off, and the supply is obtained through the 6, 5 and 4-foot conduits, the well has to be pumped down 9 feet 6 inches to provide the daily supply, the water in lake being 12 inches above zero. As the top of the 4-foot conduit, where it enters the well, is only 7 feet 1 inch below zero, the water in the well is consequently 1 foot 5 inches lower than the top of 4-foot pipe.

It will be seen, on reference to the profile above referred to, that the 5-foot pipe is too near the surface at times when the water in the lake is at zero, or below that height, to deliver more water than is at present required for daily consumption.

In order to ascertain approximately how much water the existing conduit system could be depended upon to deliver at a time when the water in the lake was at zero level, as well as what loss of head was due to obstructions, etc., in the conduits, by comparing the actual head with that calculated by formula, simultaneous measurements were taken every 30 minutes, from 10 to 12 a.m. and from 2 to 4 p.m., at the connecting cribs, manholes and well at engine-house. At the same time records were kept of the work performed by the pumping engines and the rate per day calculated from these returns, after allowing a fair percentage for slip.

As there were practically no variations in the measurements made between 10 a.m. and 2 p.m., these were taken in plotting the hydraulic grade-line, and also for calculating the flow by formula. The results found were, that taking the engine records, and allowing 6 per cent. on the old engines, and 4 per cent. on the new for slip, water was being delivered at the well at the rate of 22,500,000 imperial gallons per 24 hours

While by D'Arcy's formula the head consumed on the 6-foot pipe was sufficient to deliver 32,000,000 gallons, on the 5-foot pipe 28,000,-

000, and on the 4 and 3-foot pipes 29,000,000 gallons per 24 hours; or, expressing it in friction head, the total measured head was 6.50 feet to deliver 22,500,000 against a calculated head of 3.91 feet, showing a loss of 2.59 feet, the water in the lake being 1 foot 9 inches above zero. On plotting the grades it was found that when the water in the lake fell to zero the hydraulic grade-line would touch the top of the pipe, so that all the water the present conduit system can be depended upon to deliver at the well when the lake level is at zero is 22,500,000 gallons, and not 40,000,000 as expected. It is evident that when the lake falls below zero, which it does every year, even this amount could not be obtained.

Owing to the impossibility of emptying any of the conduit pipes, I have not been able to ascertain whether the loss of head is due to contraction of the pipe areas, caused by sand deposited in them, or whether some portion of the loss might not be attributed to the irregularity of grade in same, as well as to the obstruction offered by the projecting rivet-heads and ends of plates, which no doubt in a measure affect the flow. If the flow is calculated by D'Arcy's formula for foul or tuberculated cast-iron pipes, the results are slightly less than the engine rate obtained. A rough calculation of the number of rivet-heads projecting in the pipes between the shore crib and pumping-well makes their number over 180,000, the depth of rivet-head being about 9 16 inch. Add to this the thickness of plate every ten feet, and it will be seen there is considerable roughness in the pipes, which makes them conform more to the condition of tuberculated pipes than smooth, clean ones.

Yours truly,

C. L. FELLOWES,

Engineer in Charge of Water Works.

5 FT. STEEL CONDUIT—FIRST BREAK SOUTH OF HANLAN'S.

4 FT. STEEL CONDUIT—FIRST BREAK NORTH OF HANLAN'S.

5 FT. STEEL CONDUIT—BROKEN FLANGE IN BLOCKHOUSE BAY

REPORT OF ENGINEER IN CHARGE OF REPAIRING THE DAMAGED CONDUITS.

E. H. KEATING, ESQ.,
City Engineer:

DEAR SIR,—On Christmas Day, 1892, the 4-foot steel conduit in Toronto Bay suddenly rose to the surface, and having subsided left two of the flexible joints above the surface of the water, or rather above the ice, as the bay was then frozen to a thickness of about five inches. One of the exposed joints was 125 feet north from Hanlan's crib, and the other one 1,200 feet further north.

The 5-foot steel conduit in Blockhouse Bay had also risen at the same time, and had left two portions (about 100 feet each) exposed above the ice. The breaks in this pipe that were visible were at the cast-iron flange joints, and were respectively 2,365 feet and 3,700 feet southward from Hanlan's crib.

Sand-pumps and portable engines were placed on the works, it being found, on sounding around the risen portions, that the ground from which the conduit had risen had closed in and formed a solid support for the risen conduit.

Work commenced upon the 4-foot pipe north of Hanlan's crib by a thorough examination of the whole of the pipe, from Hanlan's crib to about 150 feet north of the exposed joint nearest to the City, with the result that one of the seams, about 20 feet south of the north joint, was torn partly asunder, leaving an opening on the under side of the pipe of from 4 to 4½ inches; and on Wednesday, the 4th of January, 1893, we found one of the flexible joints, 475 feet north of Hanlan's crib, had been forcibly pulled apart, the turned zone being pulled out of the angle iron and lead rings and lay 22 inches open, through which opening the water supply was being drawn.

Preparations were then made for covering the torn seam above mentioned, but as the shape of the pipe made it impossible to lay it on the bottom, we determined to haul the torn portion westward,

using the nearest flexible joints as pivots, which was eventually done by placing cables on pipe and powerful winches on the west side. This brought the opening to the west side. Dimensions and angles were taken and sleeve ordered (as shown by Sleeve 1, Figs. 1 and 2). Meanwhile a temporary covering of canvas was placed over the break and the sand pumped and dredged from under the pipe; a strip of galvanized iron, of sufficient length and width to cover the opening, was sewn between two pieces of canvas and lashed around the pipe with strong rope; then two thicknesses of canvas were placed over this, and securely lashed on each side by six strands of rope. The steel sleeve when ready was placed over this without disturbing the canvas and sheet-iron covering. On the inside of each half of the steel sleeve, and about four inches from each edge, a piece of extra strong rubber hose was sewn with copper wire through small holes drilled through the steel about six inches apart; the cut ends of the rubber hose were left projecting about one-quarter inch from each edge, so that when the two parts were bolted together, with the solid rubber joint pieces (1¼ inch thick) between, the ends of the hose were forcibly pressed into the joint pieces, thus making the sleeve perfectly water-tight all round. The rubber joint pieces were made so as not to touch the water conduit, except for about four inches on each end, to leave a space for the Portland cement, which was ultimately poured around between the sleeve and pipe, for which purpose two 2-inch holes, with screw-plugs fitted to them, were drilled on the top side of each sleeve. The flexible joint north of this break was successfully lowered on the 31st of January, and measured from the top of the pipe to the surface of the water 4 feet 8 inches. The steel sleeve was put on and bolted up on February the 5th, and as an extra precaution the outside edge was caulked all round with hemp soaked in tallow.

At the same time the before-mentioned work was being done, the sand and stones were being removed from under the flexible joint and pipe near Hanlan's crib, both by steam-pump and by hand dredges. It being found necessary, in order to close the open joint and bring the one above the surface down, that the whole piece between these points (350 feet) would have to be hauled northwards, a number of strong cables were procured, and two were got under the pipe and secured to heavy timbers and to screw-jacks, it being found impossible to get more cables under, three pairs of heavy tongs—similar in con-

SLEEVE No 1.

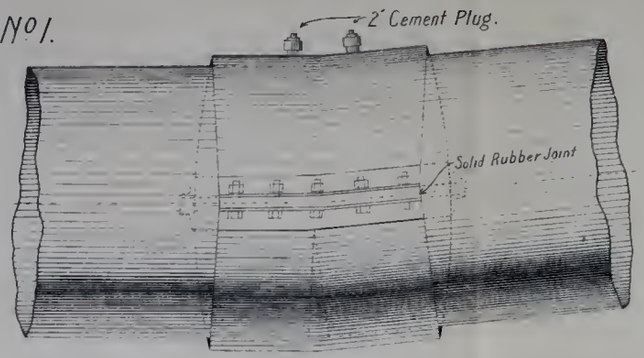


FIG. 1. Elevation

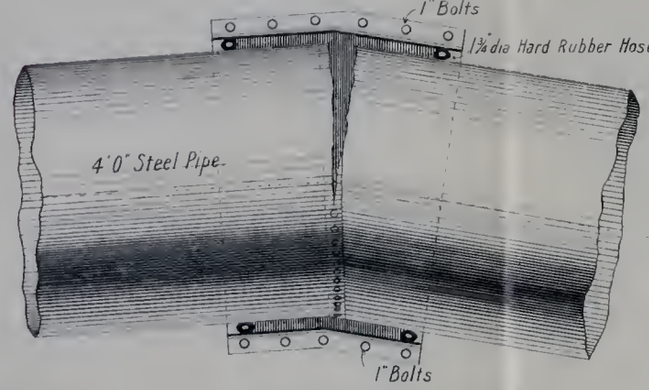


FIG. 2. Sectional Plan.

This Sleeve covers the fractured seam in 4'0" Steel Pipe in Toronto Bay. 1300 ft North of Hanlan's crib.

SLEEVE No 2.

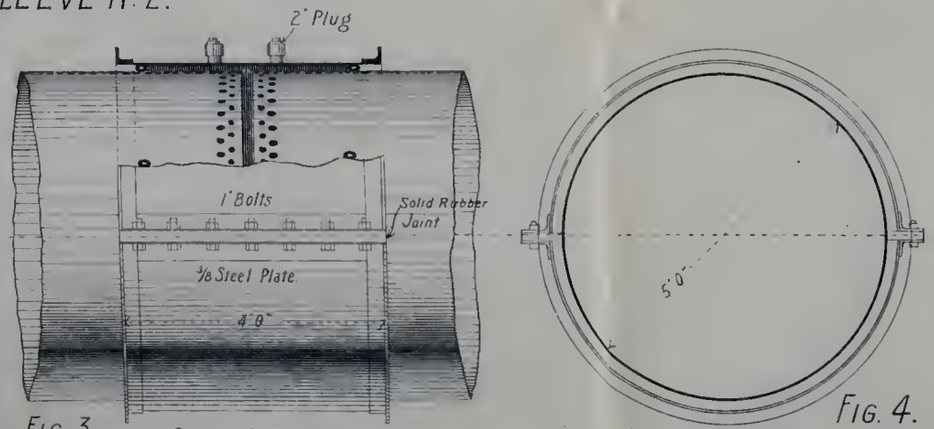


FIG. 3. Sectional Elevation

FIG. 4. Transverse Section.

This sleeve was used in two places where cast iron flanges were cut off from 5'0" pipe in Blockhouse Bay, 2305 ft and 3700 ft South of Hanlan's crib.

SLEEVE No 3.

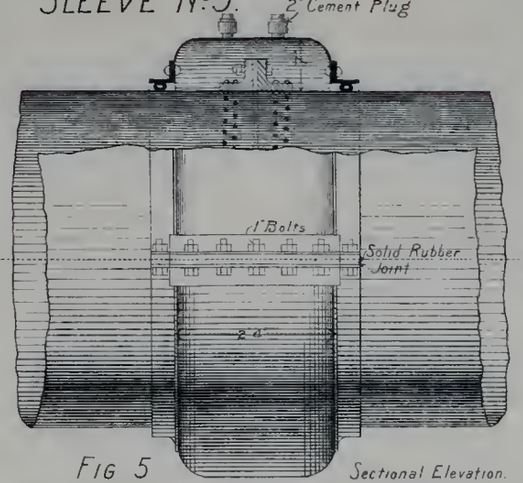
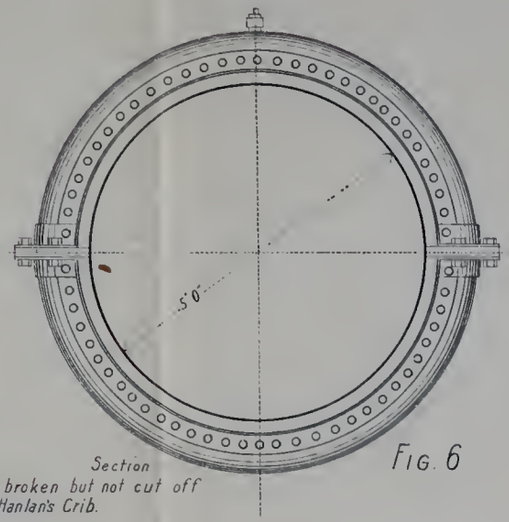


FIG 5 Sectional Elevation.



Section FIG. 6

This sleeve was used in two places, where cast iron flanges were broken but not cut off from 5'0" pipe in Blockhouse bay, 2490 ft and 3825 ft south of Hanlan's Crib.

FINAL SLEEVE OR No 4.

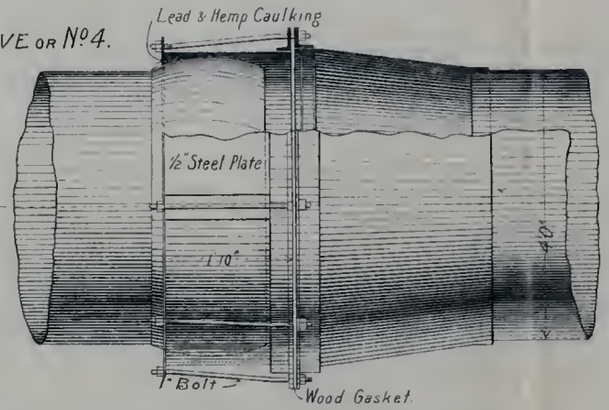


FIG. 7. Sectional Elevation.

This sleeve covers broken flexible joint on 4'0" pipe in Toronto Bay 475 ft. North of Hanlan's crib.

E. H. Keating
City Engr.

REPAIRS TO WATER CONDUITS — TORONTO WATER WORKS.

DETAILS OF STEEL SLEEVES.

SCALE ½ INCH = 1 FOOT.

J Williams, C.E.

Alexander & Cable Co. Ltd. Toronto

struction to ordinary ice-tongs—were made so as to fit the curvature of the pipe and grab it tightly; these were placed in position, with heavy timbers and screw-jacks as on the cables; by this means the whole piece was raised from the bottom, long cables were attached to pipe and to heavy winches, and all hauled northwards until the exposed joint sank below the surface. This was done on the 22nd January, and measured 3 feet 6 inches from the top of pipe to the surface of the water, and the open joint, 22 inches wide, was reduced to 5 inches. As this was the only means of supply to the City, the ends of the pipe were raised from the bottom and securely packed upon wooden boxes filled with stone. The north end was raised half its diameter above the other, so as to give ample area.

While the work in Toronto Bay was in progress, preparations were being made for raising the broken portions in Blockhouse Bay. Piles were driven on both sides of the exposed pipe, and heavy cross timbers placed thereon; cables or tongs were placed around the pipe and attached by chains and screw-jacks, four to each cable; the remaining bolts were taken out of the broken flanges, and the entire flanges removed. This was done on February 11th. Meanwhile steel sleeves (No. 2, Figs. 3 and 4) were prepared and were so formed that when in position they would act as expansion joints as well as covers. The same means of making the joint were followed as in sleeve No. 1, both as to canvas joint and final bolting up of steel sleeve. During the raising of this pipe it was discovered that another of the cast-iron flanges was fractured, but not sufficiently so as to render its entire removal necessary; so a hollow sleeve (No. 3, Figs. 5 and 6) was placed over this joint; but instead of galvanized iron being used with the canvas cover, sheet lead was carefully beaten around the fractured portion and then covered with two thicknesses of canvas and two thicknesses of cotton cloth, each covering being securely lashed to the pipe with rope.

In order to get a full supply of water, the above-mentioned portion of the work was left after the pipe was sunk to 1 foot 6 inches below the surface, and the work on the most southerly portion, which was almost identical, was proceeded with. A fractured pair of flanges were removed and joint covered after being cut off. Another pair of fractured flanges were covered by hollow sleeve as before, and this section was finally lowered into position on Thursday, the 2nd of March, and lies 2½ feet from top of pipe to surface of water

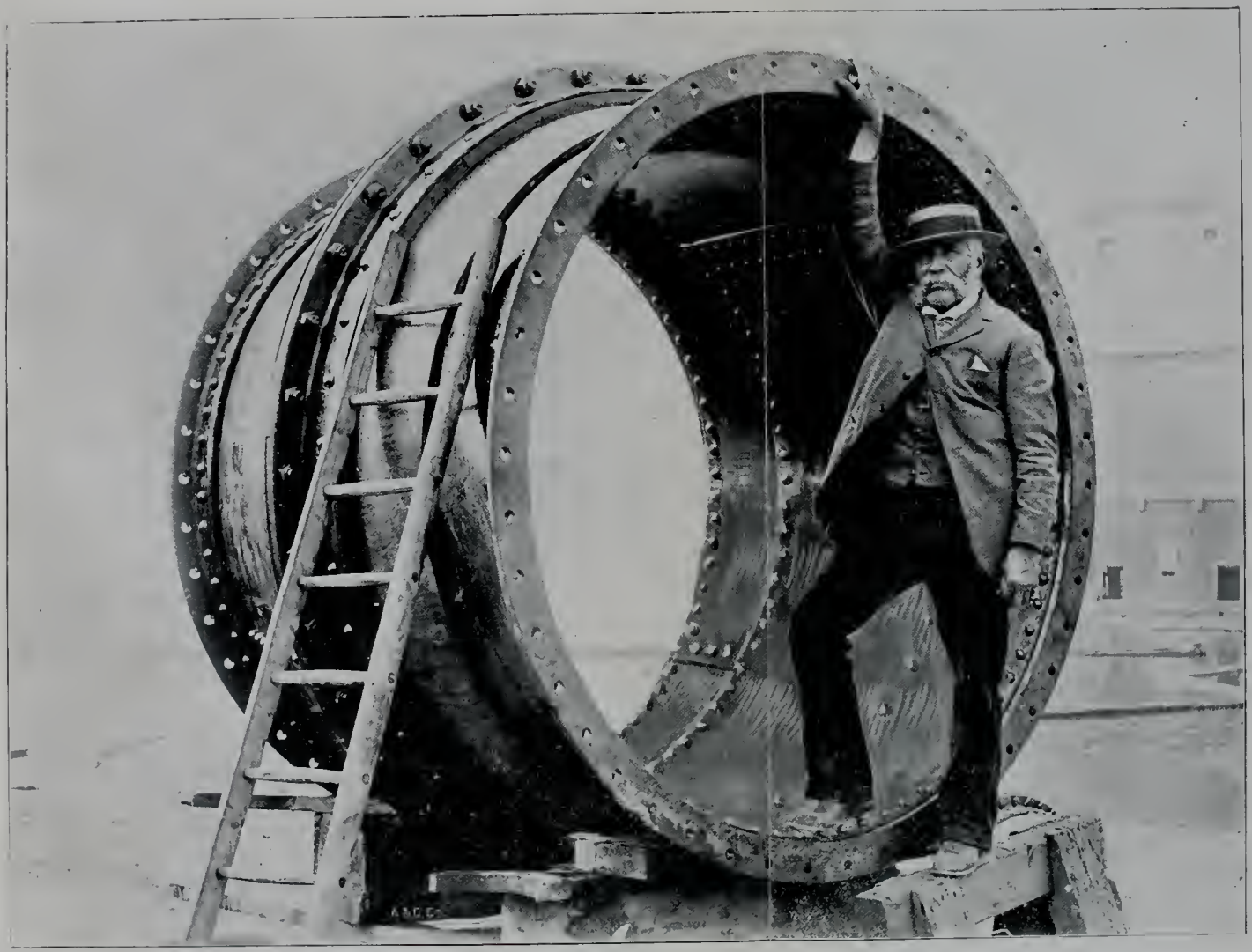
Work was then resumed on the northerly portion in Blockhouse Bay. We found, on trying to place this portion lower, that a large quantity of stone would have to be removed, and seven boxes filled with stone, on which the pipe originally lay, would also have to be removed. The pipe was again slightly raised, the stone and boxes removed; the pipe was then lowered to 3 feet 1 inch below the surface. This was accomplished on the 19th of March.

Work in Blockhouse Bay being practically completed, men returned to the 4-foot pipe north of Hanlan's crib, and prepared to put on final sleeve. A sketch of this sleeve (No. 4, Fig. 7) is shown. The south part of this sleeve was made on the angles taken from the flexible joint, and was slipped over the raised portion of the pipe, which, on being lowered, was bolted in its original position; which being done, the space between sleeve and zone was caulked in the first place by a ring of heavy lead pipe, firmly driven in afterwards by several strands of plaited hemp and tallow gasket. As cement could not be used in this sleeve, caulking was most carefully done, and a ring, as shown on sketch, was drawn up close to the packing by the eight long bolts.

It was now assumed that all the various sleeves had had time to finally settle, the cement was prepared for pouring around them, commencing at the most southerly one. Twenty-one barrels of Portland cement was used, the hollow sleeves, No. 3, taking seven barrels each, the two sleeves, No. 2 and sleeve No. 1, taking over two barrels each.

EXAMINATION OF 4-FOOT CONDUIT ACROSS THE BAY.

A careful examination of the 4-foot pipe across the bay, commencing at the Water Works dock, was begun about March 20th and continued until the whole of the sixty-three flexible joints had been examined and re-caulked. Many of the joints near the Water Works dock were buried over two feet below the mud, which had to be removed. In most cases the leakage was very slight, and only the existing lead was caulked, but in a few cases from 4 to 5 lbs. of cold lead in strips was caulked in. Only the upper half was caulked in this manner, as the weight of the pipe itself kept the lower half tight.



6 FT. STEEL INTAKE PIPE IN LAKE ONTARIO—FLEXIBLE JOINT.

EXAMINATION OF 6-FOOT STEEL PIPE, LAKE EXTENSION.

On May the 9th, at bell-buoy crib, it was found that the steel pipe had parted from the wooden one and left an opening an average of 23 inches. There was little or no accumulation of sand at this point, owing to the strong current. Apparently all the City's supply of water was being drawn through this opening. The next joint in the steel pipe, which we will call No. 2, south of the crib, was found good. The boxes under the pipe and supporting same were tipped up on the west side, showing a movement of the pipe eastward. It was nearly half buried. The bottom is muddy, clayey sand, with grass and weeds.

Joint No. 3.—This is the one where the grade of bottom changes. Found no preparation was made for this in the ends of pipes, both ends being square with axis of pipe. This joint was supposed to be covered with a sleeve of steel or lead. The pipe at this point was separated about 11 inches, and had been evidently fastened together with long bolts, a few of which were in the holes, twisted very much and the nut ends wrenched off. This partially jointed flange had fallen entirely off the crib, where it was originally placed, the west side of the north pipe being 2 feet east of the crib; the south pipe was 3 feet further east. The crib remained in its original place. Apparently no preparation had been made on this crib, such as a "cradle," to prevent the pipe from rolling off. From the top of the crib to the bottom of the lake was 6 feet 3 inches. The ground here was covered with large and strong weeds, the pipe having over 2 feet of sand in it.

Joint No. 4.—This joint was all right, the bolts being undisturbed. It had fallen off the trestle and lay some 4 or 5 feet east. The trestle had canted somewhat towards the east. Pipe buried in the sand about 2 feet.

Joint No. 5.—This joint was open about 4 inches; bolts all wrenched off. Bottom, clayey, sandy mud. Water here is 66 feet deep.

Joint No. 6.—This flange was found all right, being close all round. There was a space of about 2 feet 6 inches between bottom of pipe and bottom of lake. It seems to have moved eastward about 5 feet, as the boxes on which it originally rested were still in place

some 3 or 4 feet west of pipe, but tilted up. The bottom is clayey, sandy mud, with weeds. Water, 70 feet deep.

Joint No. 7.—This joint was open about 2 inches, all the bolts remaining in the holes being badly twisted and broken. There was a space of about 2 feet between bottom of pipe and bottom of lake. Water here 72 feet deep.

Joint No. 8.—This joint was open about 5 inches, and had every appearance of never having been closed, as only 2 or 3 long bolts were found in the holes, and 2 marlin spikes, about 18 inches long, driven in and the ends turned down.

The crib at the new intake end was all right, except the grating in the centre pocket, which was partly gone and the remainder partially covered with stone that should have been in the other pockets. The crib seems twisted a little to the east.

It being found necessary to take up and re-lay the 6-foot steel pipe, a contract was entered into with Mr. A. J. Brown, of Toronto, dated June 6th, 1893, who began the necessary preparations in building scows and providing tools, etc.

Work actually began in cutting away and raising pipe on June 30th. On the 21st July the first chains were fastened to the pipe. The first length of pipe was towed to the Water Works wharf on July 24th; it was nearly full of sand. A section of this pipe was detached and sent to Peterboro' to have T-end fitted and rivetted on.

Second pipe was raised and towed to wharf on the 27th July. This was also nearly full of sand.

Third length raised and towed to wharf on the 31st July. Full of sand as before.

Fourth length raised and towed to wharf August 4th.

Fifth length brought in August 5th.

Sixth length raised and towed in August 10th.

On the 16th of August the first length was launched in dock, preparatory to being taken out again. It floated 4 feet 2 inches out of the water.

August 19th. Two other lengths launched from dock.

Seventh length raised and towed in August 21st.

Eighth or final length was raised and brought in August 22nd.

Preparations were now made for re-laying. Soundings were taken, profile was made, and position of the two new flexible joints was located. These joints had been ordered from the Central Bridge Co., Peterboro'.

On the 26th of August all the bolts were removed from flange of wooden pipe, reversed, and countersunk into the oak, to make room for the final sleeve. The intake section was bolted to pipe floating in dock on August 28th. The first flexible joint attached to floating pipe on the 31st. The first section, consisting of four lengths and one flexible joint, was made up and all ready for towing out. This section was successfully laid on the bottom of the lake on September 15th.

The second section was loaded up and ready to go out on September 18th, but did not succeed in placing the pipe until the 23rd, when flanges were drawn together and some drift bolts placed.

September 26th the final connecting sleeve at bell-buoy crib was put in position, and length of last section of pipe ascertained.

All the pipe being now laid except the last short piece, preparations were made to test by force-pump. Tight wooden buttons were placed on intake end and on end next bell-buoy crib, and a pressure of 6 lbs. on the square inch maintained for about ten minutes. This was very satisfactory.

On October 5th the bell-mouth end and vertical screen was taken out and placed in position.

October 12th the last short length was taken out and lowered into position; between 20 and 25 of the bolts put in end resting in bell-buoy crib.

On the 13th and 14th a very severe storm raged, and when divers went down on the 16th found last length torn away from the others, all the bolts being broken and scattered. The flange had been knocked out of shape by battering on the other length. It had slid down about 10 feet southward, and had plates in two first rings very much dented. It was raised and towed ashore for repairs.

On October 25th this length was again laid and bolted in place. The final sleeve was drawn into place and caulking finished on November 7th.

On account of the large gap in the crib where pipe rests, it was thought wise to place some heavy timbers across the opening over the pipe. This was done, and four heavy iron straps placed across them and securely spiked to crib.

On the 11th November, Mr. Brown, Mr. Hockin and self put on diving suits and went down to bell-buoy crib, to see if the joint was properly made. Found all right, and a very good job.

STEEL LINING TO HANLAN'S CRIB.

On examining this crib for the purpose of testing it, the inside pine lining was found to be loose, and portions of the former cast-iron guides still remaining. It was, however, determined to construct heavy timber guides and gates with rubber faces, so as, if possible, to pump the crib out and ascertain its condition. On this work being finished an attempt was made to pump it out, but without success. The water was lowered about 3 feet, but it was impossible to pump it out any further, although powerful centrifugal pumps were used, with steam-engine running at 250 revolutions per minute, and a stream of water 5 inches diameter being discharged, thereby showing very considerable leakage.

It was then determined to insert a steel lining in this crib, with the necessary guides and gates, so as to securely close, if necessary, all the openings, viz., 5-foot inlet and two 4-foot outlets, one of the 4-foot outlets being to the old 3-foot cast-iron pipe. A contract for this work was eventually entered into with the Doty Engine Co., of Toronto.

The lining was in place, the sleeves thoroughly caulked, and the intervening space filled with Portland cement (30 barrels were used), by November 27th.

Tested the work, by pumping out after closing gate. Was able to pump all the water out of the crib, and found everything very satisfactory.

The house over the crib was re-erected mostly new, crib lined above the tank, and all cleaned up and painted.

BELL-BUOY.

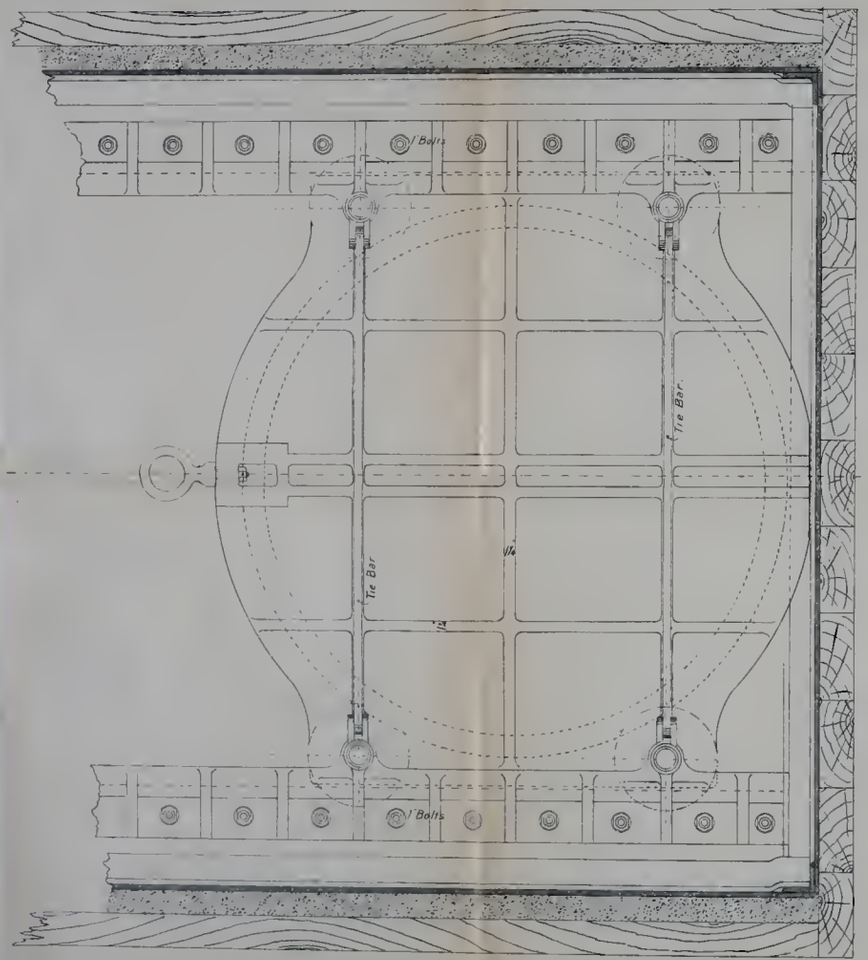
During the storm of October 14th and 15th the bell-buoy was dragged from its anchorage and found stranded on the breakwater on

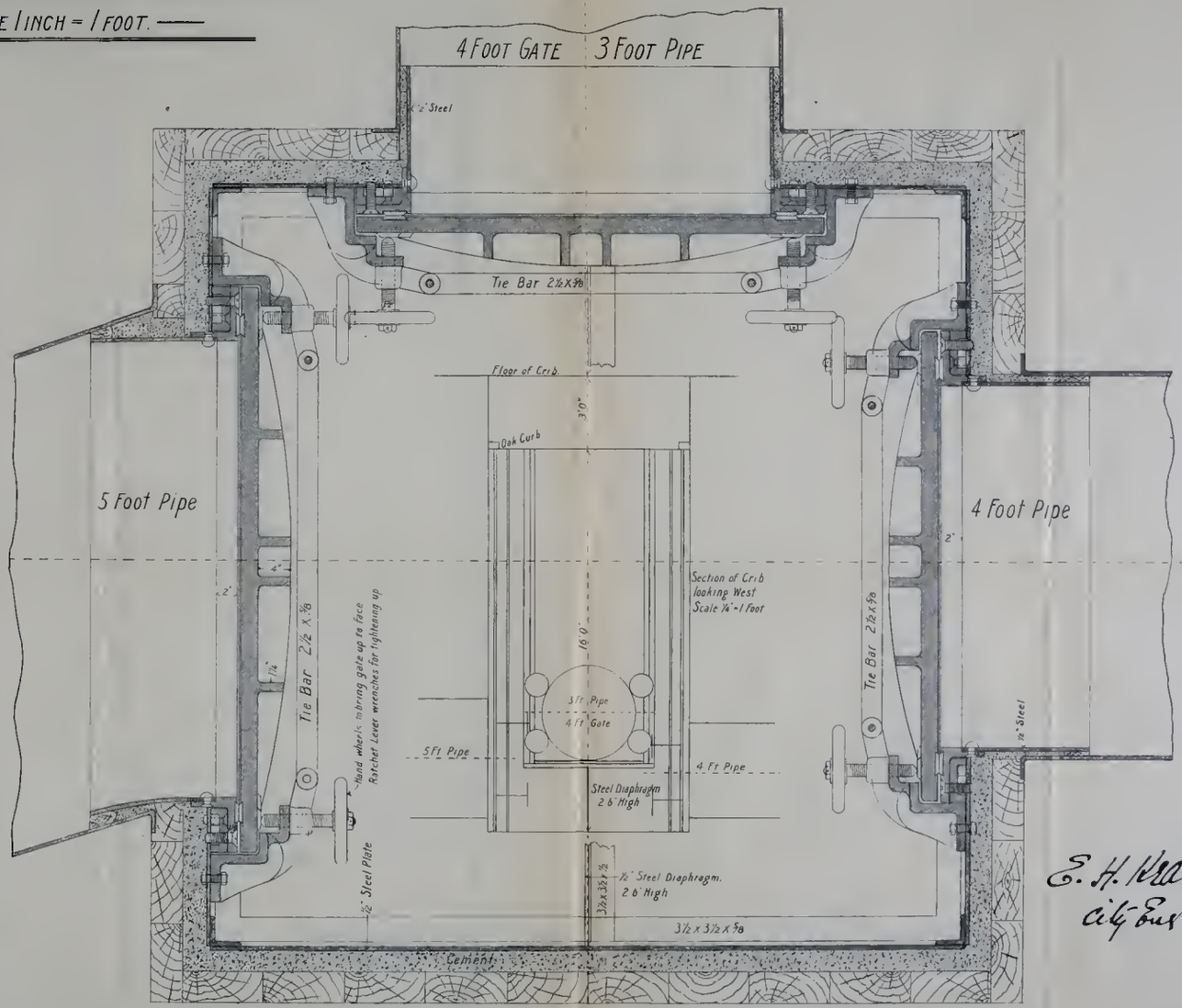
— TORONTO WATER WORKS —

— HANLANS CRIB —

— STEEL LINING AND GATES —

— SCALE 1 INCH = 1 FOOT. —





E. H. Keating
City Engr.

— CITY ENGINEER'S OFFICE —
— TORONTO. —

Alexander & Cable Co. Ltd. Toronto

J. Williams C.E.

TORONTO WATER WORKS

the east end of the Island. An ineffectual attempt was made by divers to find the anchor and cable, so a new one was ordered, the bell-buoy repaired and made all ready for re-placing in the coming spring.

EXAMINATION OF 6-FOOT CONDUIT.

This work was commenced on the 23rd November, as it was found that some 30 inches of sand had accumulated in this pipe. It was determined to construct manholes at intervals, and pump out the sand by centrifugal pump. This work was prosecuted for about four weeks, and again resumed early in January of 1894.

Respectfully submitted.

JOHN WILLIAMS, C.E.,
Engineer in Charge.

ANNUAL REPORT OF CHIEF ENGINEER AT MAIN PUMPING STATION.

MAIN PUMPING STATION,
TORONTO WATER WORKS, January 1st, 1894.

E. H. KEATING, ESQ.,
City Engineer:

DEAR SIR,—I herewith submit to you the annual report of this station for the year 1893.

When appointed as Chief Engineer I found the entire plant in a very unsatisfactory state of repair. The engines were not pumping their normal capacity of water daily, and the boilers and boiler feed pumps were badly worn. I immediately commenced to have them re-built We started to re-build Nos. 1 and 2 engines, and also to repair boilers Nos. 1 and 2, on May 1st; completed repairs to same, and started them running, on the May 27th. We then commenced repairs to boiler feed pumps of engine No. 3, and five boilers of battery No. 3; completed the same by August 15th. Since then all three engines, boilers and boiler feed pumps have been in first-class condition, so that at present we are prepared to supply any demand.

Below I subn it to you a summary of repairs to engines, boilers and boiler feed pumps, and other work done during the year:

SUMMARY OF REPAIRS TO ENGINE No. 1.

1. Plungers and rods taken out and trued up in lathe; pressure piston-rods and sleeves turned and bushed.

2. Glands bushed and neck-rings for stems on steam-chests; new valve-stems, with brass bushings and glands for same; air-pumps re-built all through; air-pump rods lined with brass; air-pump buckets re-packed; new rubber valves, brass covers, and springs for same.

3. New rubber joints on suction and discharging sides of pumps; new joints to steam-chests and cylinders. This completes the repairs to engine No. 1.

SUMMARY OF REPAIRS TO ENGINE No. 2.

1. Plungers and rods taken out and trued up in lathe; glands bushed and neck-rings turned and bored for stems on steam-chests; new valve-stems, with brass bushings and glands for same.

2. Fitting copper pieces inside of rings of air-pumps, set reverse keys; new pin and bush for air-pumps.

3. New rubber valves with brass covers, and springs for air-pumps; the main pump seats all removed, cleaned and replaced with new rubber joints.

4. Pump plungers trued up, and brass liners for same; new low-moor bolts for holding new phosphor bronze liners in place. This completes the repairs to engine No. 2.

SUMMARY OF REPAIRS TO ENGINE No. 3.

1. Main shaft, which was broken, taken out and replaced by new one; disk taken off old shaft and placed on new one.

2. Main pumps all bored out and new bushing put in same; new plungers put in all round; valve-seats all faced off, and new set of valves put in pump; new steel pieces put on top of ports of pumps, with $\frac{3}{4}$-inch patch screws.

3. New brass liners for plungers: new valve-stems, with a number of valve-seats and valves, and air-pumps re-packed and new stems for same; pump cylinder covers trued up; new covers to hold sleeves in place.

4. All engine and pump bearings re-babbitted; crank-pins all trued up; engines and pumps all lined up; steam pistons taken out and re-fitted; engine bolted solid to foundation; air-pumps all re-built; which completes the repairs to engine No. 3.

SUMMARY OF REPAIRS TO FOUR BOILERS OF BATTERY No. 1.

1. Newly lined fire-boxes and combustion chambers; new baffle-plates to fire-hole doors; new $\frac{1}{2}$-inch globe valves, asbestos and blow-off cocks and plug-cocks; new grate-bars to furnaces.

2. New rubber gasket rings for joints of manhole covers; and the plates and girders used in connection with setting being burnt out, have all been replaced by new brick arches.

3. New joint to steam-pipes; safety and stop-valves; new fire-bricks, clay and mortar for inner walls; tubes all thoroughly cleaned out, which completes the repairs to boilers of No. 1.

SUMMARY OF REPAIRS TO FOUR BOILERS OF BATTERY No. 2.

1. New grate-bars to furnaces; new 2-inch globe valves, asbestos and blow-off cocks and plug-cocks; new rubber gasket-rings for joints of manhole covers; new baffle-plates to fire-hole doors.

2. Newly lined fire-boxes and combustion-chambers; new fire-bricks, clay and mortar for inner walls; and the plates and girders used in connecting with setting being burnt out, have all been replaced by new brick arches.

3. New joints to steam-pipes; safety and stop-valves; tubes all thoroughly cleaned out; furnaces re-lined and side walls re-built. This completes the repairs to boilers of No. 2.

SUMMARY OF REPAIRS TO FIVE BOILERS OF BATTERY No. 3.

1. Newly lined fire-boxes and combustion-chambers; new baffle-plates to fire-hole doors; new fire-bricks for furnaces and side walls new grate-bars to furnaces.

2. New 2-inch angle-valves; asbestos cocks, blow-off cocks, plug-cocks; new ¾-inch and 2-inch globe valves; clay and mortar for brick work; new joints to steam-pipes, safety and stop-valves.

3. Furnaces re-built from bottom to back end; top arches all renewed; tubes expanded and thoroughly cleaned out, which completes the repairs to boilers of No. 3.

SUMMARY OF REPAIRS TO MAIN BOILER FEED PUMP.

1. New sleeves for plungers; new pump-rods and new brass head gibs for cross-heads; new glands and neck-rings.

2. New joints made all over; main shaft taken out and lined up; new valves and pump-engine lined up; valve-seats all re-headed, and pump newly painted, which completes the repairs.

SUMMARY OF REPAIRS TO BOILER FEED PUMP, No. 1.

1. New neck-rings for pump end; new pins for valve gear; new brass glands; new plunger for pump ends.

2. New piston, spider-faced; new rods for pump ends; new steam-valves and water-valves; new sleeves; new joints on steam-chests; new rods in pump; new glands and bushing in both ends, which completes the repairs to boiler feed pump of No. 1.

SUMMARY OF WORK DONE DURING THE YEAR 1893.

1. Part of the flooring in old engine-house has been re-laid with 1-inch maple. The well is also covered with the same, with traps left for easy admittance.

2. The well in the old engine-house has been newly lined with cast-iron plates, and also thoroughly cleaned out. The leaks that were around the masonry have been stopped, and at present it is in a first-class condition.

3. The walk which was in front of boilers of Nos. 1 and 2, and also back of No. 3, has been removed, as it was badly decayed and uneven. This has been re-laid with cast-iron plates, making a first-class job.

4. The walls inside of No. 3 boiler-room were in a very dirty condition. They have been all newly whitewashed, and now have a bright and cheerful appearance.

5. The cellar under No. 3 engine was in a filthy condition, being full of water mixed with oil and grease. This has been thoroughly cleaned out, and at present is in a perfectly clean condition.

6. The foundation of new engine No. 5 is completed. It is very substantially constructed and is ready for the erection of the engine.

7. The new boiler foundations, which are built from the rock, are being advanced as quickly as possible, and will be ready for use at an early date.

8. The two hot water wells in the old engine-house, which were in a filthy condition for the want of cleaning, have been thoroughly cleaned out.

9. The new Blake engine No. 4 have been housed over inside of engine-room, to protect her from dust while the erection of the foundation for No. 5 engine is going on.

10 The flooring in basement of new engine-house, which was of concrete, was badly cracked and broken. This I have had taken out and re-laid by new concrete, and have also stopped the leaks which were numerous in walls of foundation. There also was a wall built inside for the purpose of puddling. This has been removed, and I have had a steam-pump put in the basement, for the pumping out of cellar; it is also connected to the well, so at any time when required it can be pumped out also.

11. Blake engine No. 4. There have been put in by the Blake Co. new pump cylinders, valve-seats and guide-bars; and there is also here a new bell crank ready to be put in.

I remain yours truly,

R. PINK,

Engineer in Charge.

REPORT OF CHIEF ENGINEER AT HIGH LEVEL PUMPING STATION.

HIGH LEVEL STATION,
January 11th, 1894.

E. H. KEATING, ESQ.,
City Engineer:

DEAR SIR,—I beg to submit the following report of the performance and condition of the plant under my charge.

The engines have worked without any break or mishap during the past year, no other than ordinary running repairs being required.

The boilers are sound and clean, and have not required any repairs during the year. The only mishap was the burning of a set of grates by one of my assistants, Mr. Pearce. Some necessary changes were made in the connections, to permit of repairs being made without shutting down the plant.

The pumps are in fair condition; some of the working parts are cut by sand. The sand, however, is not passing in as large quantities as formerly, and is of a much finer nature.

A new screen was placed on suction main, which prevents anything from interfering with the action of pump-valves.

The buildings are in good condition, necessary repairs having been made during the year.

The plant generally is in good condition, and I anticipate no trouble during the present year.

The roadway on the east side of buildings needs repairing. During the wet season coal cannot be delivered to sheds in its present condition.

Respectfully submitted.

CHAS. HEAL,
Engineer in Charge.

WORKS DEPARTMENT.

SEWER ENGINEER'S REPORT.

SEWER DEPARTMENT,
Toronto, Dec. 31st, 1893.

E. H. KEATING, ESQ.,
City Engineer, Toronto:

DEAR SIR,—I beg to submit herewith the following report of this Department for the year ending 31st December, 1893.

During the year 3.32 miles of sewers were constructed, of which 1.10 miles were built by day labor. The following is a detailed statement of the various works:

SEWERS BUILT BY CONTRACT.

9-inch tile pipe sewer	4,416 lin. feet.
12 " "	2,019 "
15 " "	1,590 "
18 " "	588 "
2 ft. x 3 ft. brick sewer	537 "
3 ft. 6 in. drain brick sewer	1,079 "
4 ft. drain brick sewer	1,165 "
4 ft. 4 in. steel rivetted pipe	363 "
Total	11,757 "

SEWERS BUILT BY DAY LABOR.

9-inch tile pipe sewer	667 lin. feet.
12 " "	711 "
15 " "	1,446 "
18 " "	883 "
2 ft. drain brick sewer	234 "
2 ft. 6 in. drain brick sewer	702 "
3 ft. x 5 ft. brick sewer	119 "
3 ft. x 4 ft. 3 in. brick sewer	292 "
2 ft. 2 in. wooden box	574 "
3 ft. 8 in. "	150 "
20-inch steel rivetted pipe	57 "
Total	5,835 "

In connection with the construction of these sewers, 56 manholes and 79 gullies were built.

The following statement shows sewers constructed under contract and by day labor, with cost of same per foot:

SEWERS BUILT BY CONTRACT, 1893.

Street.	From	To	Size.	Description.	Length in feet.	Manholes.	Gullies.	P.D. Connections	Average Depth in feet.	Nature of Soil.	Contract Price.	Total Cost, including Inspection.	Cost per lin. foot	Inspector.	Contractor.
Wallace av..	McKenzie av	Grogan's L..	2' x 3' 15"	Brick .. Pipe ..	537 228	5	6	26	11' 0"	Wet sand..	$ 2,612	$ c. 2,851 49	$ c. 3 72	R. Kerr	Wm. Jones.
Queen	River Don	DeGrassi ..	4' x 0" 3' x 6"	Brick {	1,165 1,079	6	1	6	16' 0"	Clay	12,699	13,350 05	5 91	F. J. Carrette ..	J. H. McKnight.
Clinton	Barton	Yarmouth	15"	Pipe ..	1,270	5	6	88	11' 6"	"	1,976	2,360 70	1 85	Wm. Hill	John Farley.
Barhurst ...	O. & Q. Ry..	Con't Home.	9"	" ..	1,682	3	1	2	6' 0"	Clay and wet sand.	860	1,118 86	66	B. J. Looman ..	Smith & Wilson.
Cattle Market Sewer.	Garrison Ck.	New Market	18"	" .	588	2	2	1	7' 0"	Clay	859	1,251 21	2 13	Wm. Ireson	A. J. Brown.
Parliament .	Extension ..	. ...	52"	Steel pipe..	363	1	... .		.....	.....	2 751 ft	1,519 37	4 26	E. Howse	Medler & Arnot.
Exhibition Sewers*	... ...	... .	15" 12" 9"	Pipe {	92 2,019 2,734	17	55	80	6' 2"	Clay	2,231	3,995 32	82	A. McCormack..	Burns & McCormack.

* 671 feet weeping tile drains, 3 brick chamber overflows, 1 bell mouth.

SEWERS BUILT BY DAY LABOR, 1893.

STREET.	From	To	Size.	Description.	Length in feet.	Manholes.	Gullies.	P.D. Connections	Average Depth in feet	Nature of Soil.	Total Cost.	Cost per lin. foot	Foreman.
											$ c.	$ c.	
Simcoe	Re-construction under tracks		3' 0" x 4' 3"	Brick	292	2		12	9' 2"	Clay	5,026 94	17 21	Geo. Carette.
Bathurst	"	"	3' 0" x 5' 0"	"	119	1					1,877 91	15 78	"
Toronto R'y sewer	Sherbourne Power House		2' 6"	"	702	3			7' 2"	Runn'g sand	3,000 00	1 27	E. Howse.
Reservoir sewer's			2' 0"	"	231	2			11' 3"	Clay	810 10	3 42	"
Lane E. Portland	Adelaide	Farley	12"	Pipe	186	1	2	28	10' 5"	"	709 96	1 46	G. Carette.
Bleecker	Carlton	Wellesley	15"	"	1,416	5		4	10' 0"	Sand	1,169 52	80	Wm. Hill.
Linden	Sherbourne	Huntley	18"	"	583				16' 1"	"	909 58	1 56	"
Isolation Hospital	sewer †		9"	"	415	1		2	11' 7"	"	689 28	1 66	"
Elliott	Broadview	Hamilton	18"	"	300	1			12' 2"	Clay	586 43	1 95	A. McCormack
Western Yard sewer			9"	"	252		3		8' 1"	"	221 19	87	Wm. Hill.
Lamport Av	Crescent Rd	181 feet east	12"	"	225	1		7	9' 10"	Hard pan	216 58	96	B. J. Loeman.
Booth			2' 2"	Box	230								
Logan			2' 2"	"	163								
Morse	Extension to Ash	bridge's Bay	2' 2"	"	92						1,390 00	5 91	Geo. Jones.
Carlaw			2' 2"	"	89								
Lake			3' 8"	"	150								

* 1 brick head. † 1 special tank.

The undermentioned work has been done during the year by the foremen on sewer repairs:

Manholes repaired	115
New manholes built	131
Gullies repaired	45
New gullies built	317
Miles of sewers flushed and cleaned	90

The following is a list of the plans made during the year:

Contract plans, sewers	13
Plans for day labor works	16
Working plans	60
Miscellaneous plans	225

FLUSHING.

During the year 90 miles of sewers have been flushed and cleaned at a cost of $5,364.47, or $59.65 per mile.

CONSTRUCTION AND EXTENSION OF SEWERS.

Queen Street East Storm Water Sewer.

One thousand and eighty-four feet of 3 ft. 6 in. and 1,165 feet of 4 ft. diam. 9 in. brick sewer has been constructed from the river Don to DeGrassi Street, on this street.

Queen Street, Bathurst Street to the Garrison Creek.

Nine hundred and eighty feet of 4 ft. and 680 feet of 3 ft. 6 in. diam. 9 in. brick sewer is now under construction between these points.

All the sewers emptying into Ashbridge's Bay have been extended towards the line of proposed channel through same.

Extension to Deep Water.

Parliament Street sewer has been extended to deep water by laying a 52-inch steel plate rivetted pipe from the south end of the present brick sewer 258 feet south to the new Windmill Line.

Simcoe Street.

A contract has also been let for the extension of the above street sewer to the face of the crib protection on the south side of Lake Street. The 48-inch steel pipe for same is on the ground ready for laying.

RE-CONSTRUCTION UNDER RAILWAY TRACKS.

Both the Simcoe Street and Bathurst Street sewers have been re-constructed where they cross under the railway tracks on the Esplanade. The former is a 7 ft. x 5 ft. brick, and the latter is a 5 ft. x 3 ft. brick sewer.

ESPLANADE IMPROVEMENTS.

All work in connection with the removal of the Argonaut, R.C.Y.C., Elgie and Noverre's buildings has been completed, and the buildings removed to their present positions on the new Windmill Line. Temporary approaches have been constructed to them.

A very large amount of cribwork for the support of these buildings, as well as for the protection of the south side of Lake Street, has been put in place. The cost of this work was $59,115.43.

The necessary cribwork for the protection of the south side of Lake Street at John Street has been sunk in place, and the cribwork extended to a junction with the Water Works dock, at a cost of $6,497.66.

A large quantity of material has already been filled in on what is known as the alternative site, as well as in Lake Street at York Street.

PLUMBING DEPARTMENT.

During the year 2.69 miles of private drains have been constructed made up of 6 in. and 9 in. pipes.

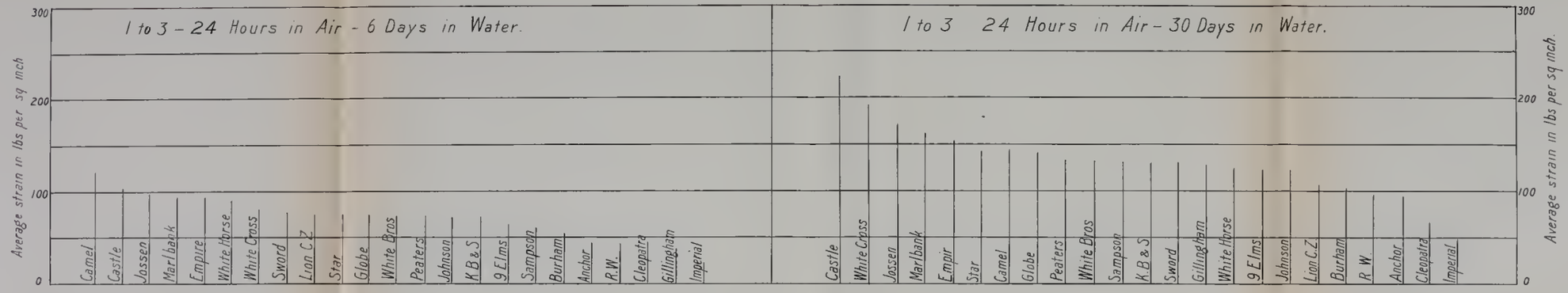
The total amount received during the year for private drains constructed amounts to $11,266.84; total expenditure, $12,064.68; refunded on repairs account, $637.20.

COMPARATIVE STATEMENT OF WORK DONE, ETC., IN 1892 AND 1893.

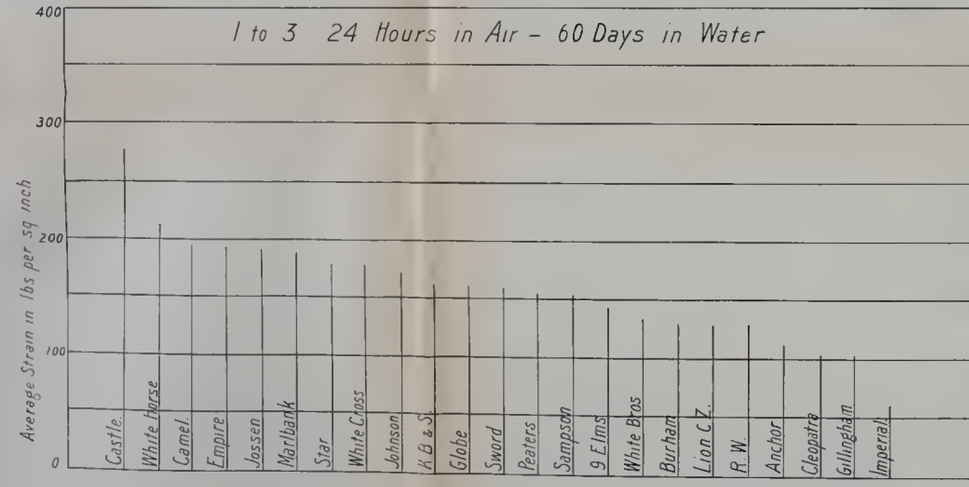
Permits Issued.

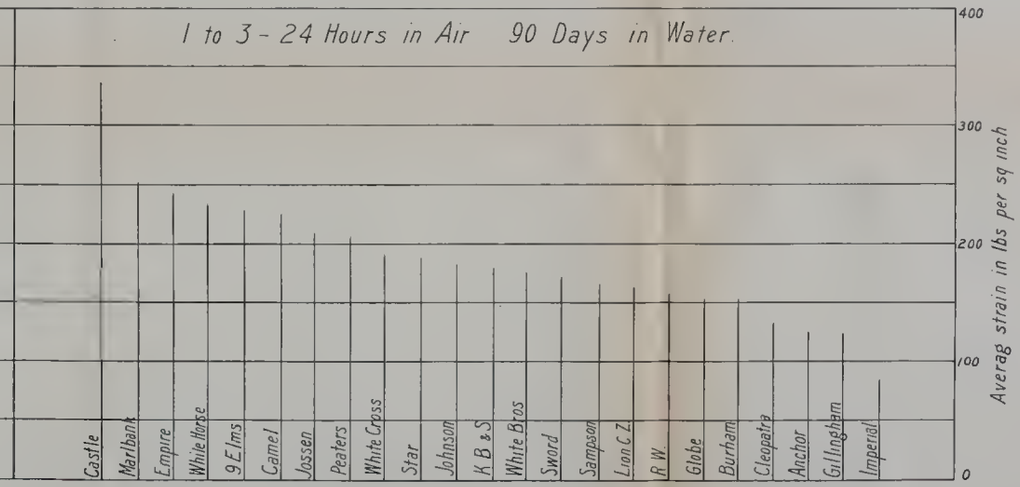
	1893.	1892.
Plumbing and drainage	483	752
Plumbing only	249	323
Drainage only	214	289
Total	946	1,364

DIAGRAM SHEWING THE STRENGTH OF VARIOUS BRANDS OF CEMENTS.



E. H. Keating
City Engr.



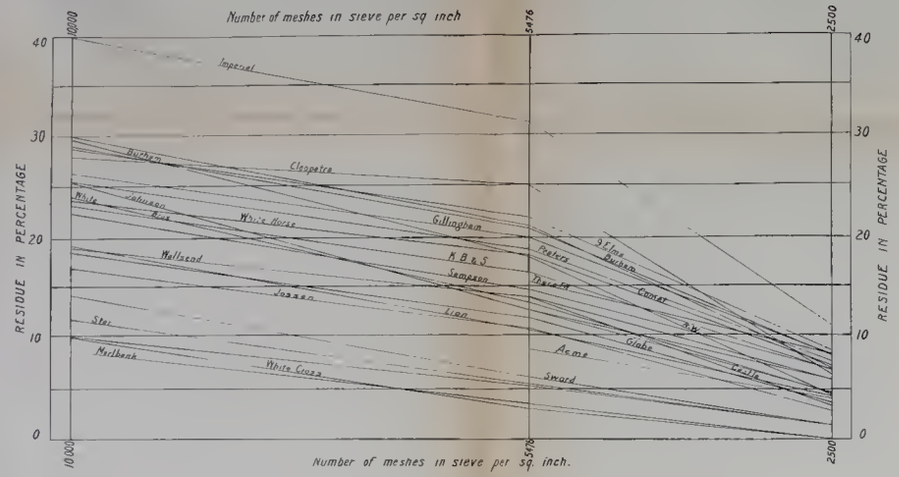


Alexander & Cable Co. Ltd. Toronto

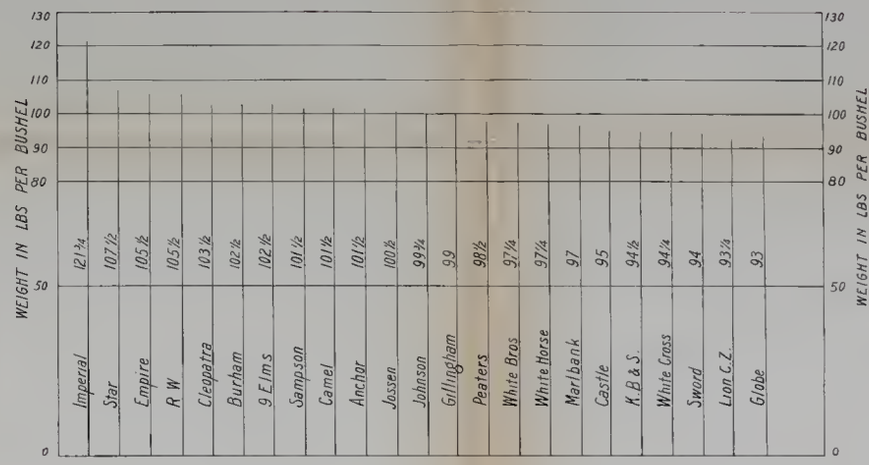
City Engineer's Office
Toronto, April -94.

DIAGRAM SHEWING WEIGHTS AND SIFTING OF DIFFERENT BRANDS OF CEMENTS.

SIFTING DIAGRAM



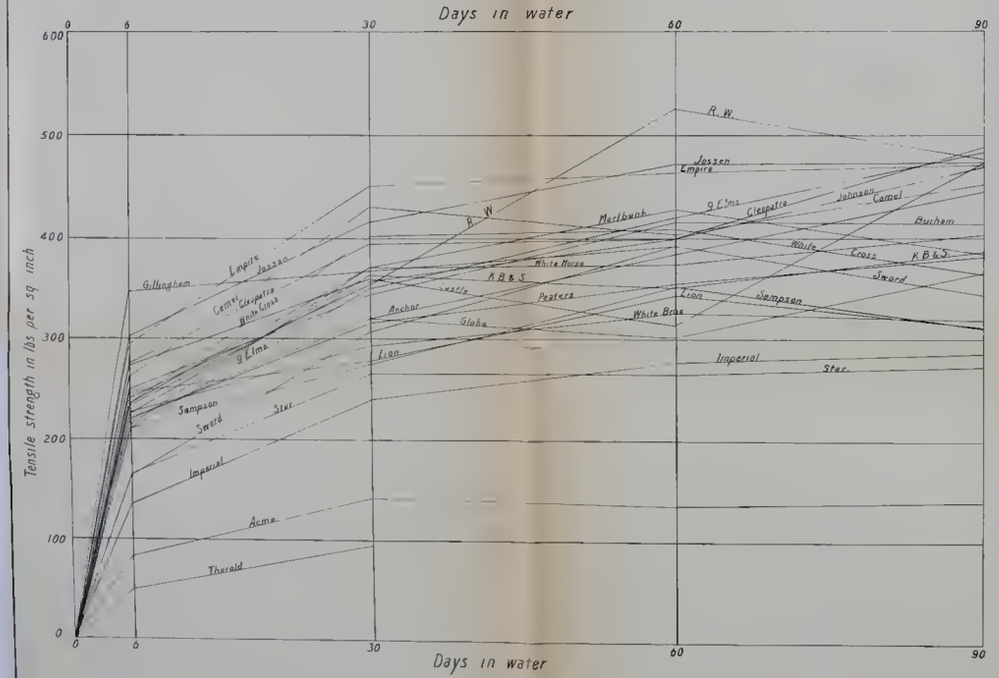
WEIGHT DIAGRAM



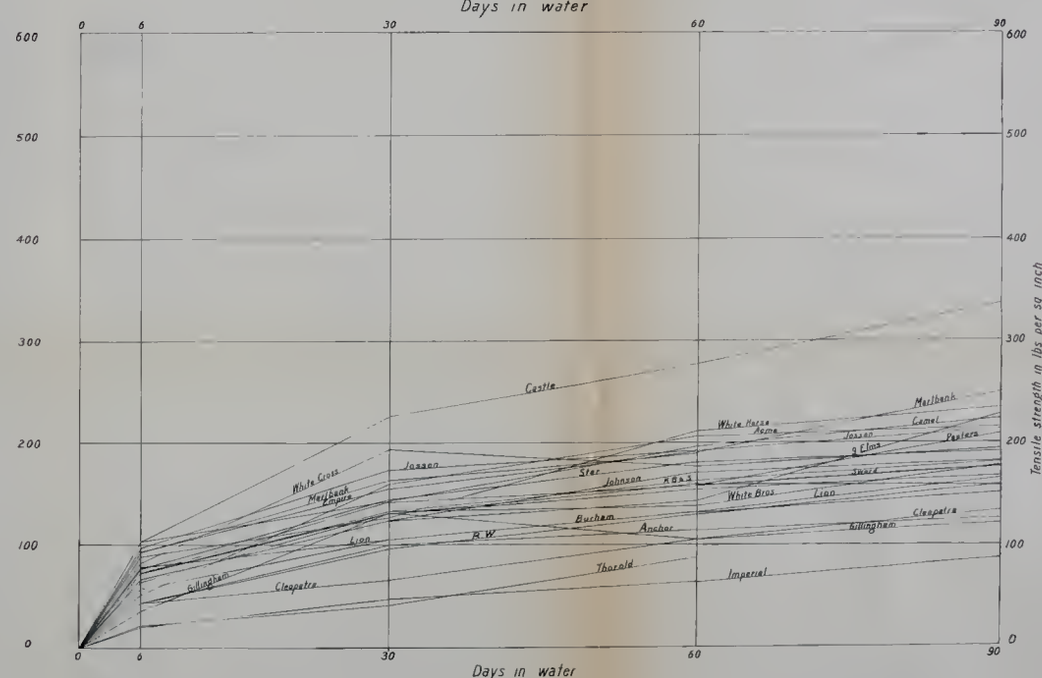
E. H. Keating
City Engr.

DIAGRAM SHEWING THE STRENGTH OF VARIOUS BRANDS OF CEMENT

NEAT CEMENT



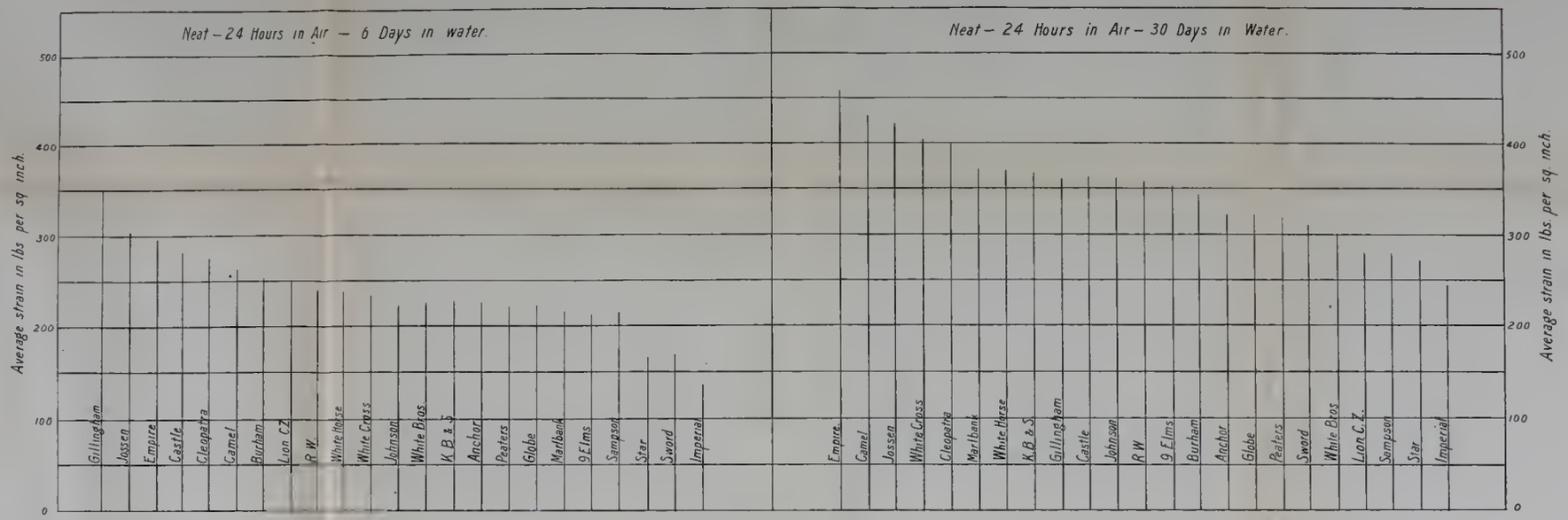
CEMENT MORTAR 3 TO 1



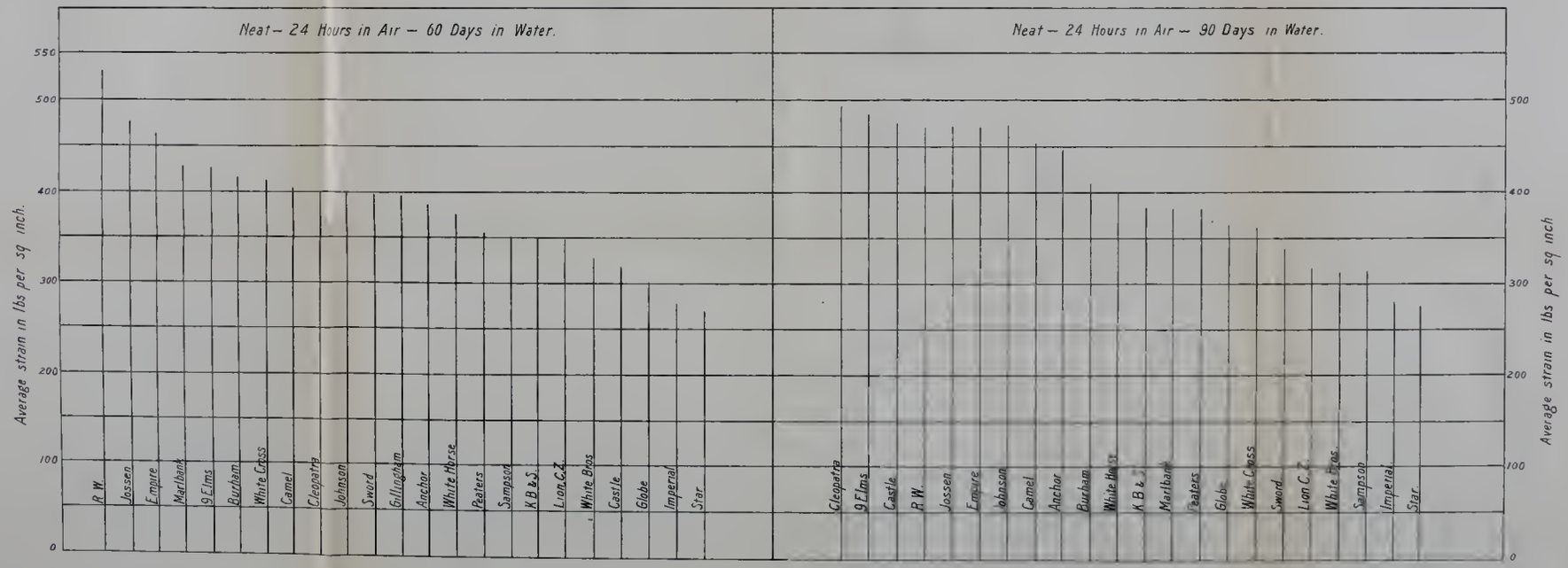
City Engineers Office
Toronto, April – 94

Alexander & Cable Co. Ltd. Toronto.

DIAGRAM SHEWING THE STRENGTH OF VARIOUS BRANDS OF CEMENT.



E. H. Keating
city Engr.



City Engineer's Office
Toronto, April-94

Alexander & Cable Co Ltd Toronto

Number of Buildings represented in Permits Issued.

Plumbing and drainage	755	1,379
Plumbing only	281	369
Drainage only	295	400
Total	1,331	2,148

Number of Inspections Made.

Plumbing	2,597	2,736
Drainage	776	1,007
Total	3,373	3,743

Number of Inspections Made.

Plumbing	6,131	4,693
Drainage	3,104	4,064
Smoke tests and final inspections	5,370	6,352
Total	14,605	15,109

CEMENT.

During the year the usual tests have been made of cements used in the various City works. The attached diagrams show the results obtained.

Yours truly,

C. L. FELLOWES,
Engineer in Charge of Sewers.

ROADWAY ENGINEER'S REPORT.

ROADWAY DEPARTMENT,
Toronto, Dec. 31st, 1893.

E. H. KEATING, ESQ.,
City Engineer:

DEAR SIR.—In accordance with your instructions I have prepared the following report upon the various works performed under the supervision of the Roadway Branch of the Works Department during the year 1893.

The total amount expended on pavements and permanent sidewalks during the past year amounted to $504,782.71. Of this sum $392,030.17 was spent in changing the pavements between the street car tracks; $102,316.50 was paid out for pavements laid upon the local improvement plan, and $10,436.04 was expended on concrete and stone flag sidewalks.

18.748 miles of new pavements and 2.294 miles of new sidewalks were constructed for the above expenditure, and the following table gives the mileage laid down during the years 1891, 1892 and 1893:

TABLE No. 1.

MILEAGE OF PAVEMENTS.

	1891.	1892.	1893.
Mileage laid	11.090	19.574	18.748

The increased mileage laid in the years 1892-93 was largely composed of permanent pavements laid in conjunction with the change in street car rails by the Toronto Railway Company.

During 1893 there were 45 contracts let and 11 remained over from 1892, making a total of 56, of which 51 have been completed, leaving only 5 to be carried out during the coming year.

In addition to the contracts already mentioned there were 21 private contracts and day labor works which were performed under the direction of this Deparment, and the following Table No. 2 shows the class of pavement, of which the various contracts consisted, making in all 74 different pieces of work which required the attention of this Department.

TABLE No. 2.

Class of Pavement.	Number of Works.
Cedar block	20
Asphalt	17
Concrete sidewalks	18
Macadam	1
Stone setts	10
Brick on concrete	7
Stone flag sidewalks	1
Total	74

In order to perform the works enumerated in the above table it was found necessary to prepare 126 plans, 321 estimates, and in addition 702 letters were received and attended to.

A comparison of the various works executed in 1890-91, 1892-93, may be of interest as showing the variation in the class of pavements now being laid in the City, and in order to do so I have had the following table prepared :

TABLE No. 3.

Mileage of Different Classes of Pavements Laid during 1890, 1891, 1892 and 1893.

Class of Pavement.	1890.	1891.	1892.	1893.
Asphalt	1.73	1.635	6.216	5.607
Cedar block on sand and plank foundations	15.51	9.186	3.349	3.249
Macadam	.....	0.123	0.494	.....
Cobble	0.10	0.069	0.366	.....
Tamarac on concrete	0.192	0.077	.....	.....
Cedar block on concrete	.....	.....	8.416	2.185
Stone setts on concrete	.....	.....	0.705	3.743
Scoria setts on concrete	0.138	.....	0.028	.....
Brick on concrete	.....	.....	.....	3.964
Total of Pavements	17.670	11.090	19.574	18.748
Concrete sidewalks	1.426	1.930	1.508	2.259
Stone flag sidewalks	1.273	0.398	0.104	0.035
Total of Sidewalks	2.699	2.328	1.612	2.294

From the foregoing table it will be seen that the mileage of cedar block pavements constructed has fallen from 15.51 miles in 1890 to 3.249 miles in 1893, whilst the better classes of pavements have largely increased. The greatest proportion of this improved work was occasioned by the necessity to construct permanent pavements in conjunction with the new tracks laid by the Toronto Railway Company; but at the same time there has been an increased demand for improved roadways on residential streets and a desire to replace the old cedar block roadways with the better classes of pavements, which should be encouraged in every possible manner, not only for the improved appearance it will give the City, but from an economical point of view, as the Street Commissioner's Department has to expend large sums annually to repair and keep clean these dilapidated roadways, which nothing short of re-paving will ever make presentable, and wherever a new pavement is constructed it means an annual saving for repairs and cleaning of an amount of money proportionate to the length of pavement constructed.

I have had a list made out of all roadways constructed upon the

local improvement system, the life of which has expired, most of which require renewal. In the majority of cases these roadways are full of ruts, and holes, the blocks being completely destroyed, so that a new pavement is absolutely necessary, and some action will have to be taken to keep them passable.

TABLE No. 4.

TABLE OF CEDAR BLOCK PAVEMENTS FOR WHICH THE TIME OF PAYMENT HAS EXPIRED OR IS ABOUT TO EXPIRE.

STREET.	From	To	Date When Laid.	Date of Expiry.
D'Arcy	Beverley	McCaul	1881	1891
St. Patrick	"	"	1881	1891
"	"	Huron	1881	1891
Selby	Huntley	Sherbourne	1881	1891
Wellesley Pl	Wellesley	A lane	1881	1891
Wellesley	Sherbourne	Parliament	1881	1891
Argyle	Dundas	Gladstone	1882	1892
Arthur	Bathurst	Lumley	1882	1892
Baldwin	Beverley	Huron	1882	1892
"	Spadina	"	1882	1892
Berkeley	Gerrard	Carlton	1882	1891
Beaconsfield	Queen	Saurin	1882	1892
Brookfield	"	Maple	1882	1892
Beverley	"	College	1882	1892
Bleeker	Carlton	Howard	1882	1892
Brunswick	College	Butler	1882	1892
Bellevue	"	Bellevue Pl	1882	1892
Brock	King	Front	1882	1892
Cecil	Beverley	Spadina	1882	1892
College	"	"	1882	1892
Dovercourt Rd	Dundas	Argyle	1882	1892
"	Queen	"	1882	1892
D'Arcy	Beverley	Spadina	1882	1892
Huntley	Bloor	Earl	1882	1892
Howard	Bleeker	Sherbourne	1882	1892
Henry	Baldwin	Cecil	1882	1892
Harbord	St. George	Huron	1882	1892
Henry	College	Cecil	1882	1892
King	Strachan	Railway crossing	1882	1891
Lumley (now Euclid)	College	Robinson	1882	1892
Lisgar	Queen	Saurin	1882	1892
McCaul	Grange Rd	Anderson	1882	1887
Murray	Caer-Howell	North end	1882	1892
Nassau	Spadina	Lippincott	1882	1892
Oxford	"	Grosvenor (now Augusta Av.)	1882	1892
Orde	College Av	West end	1882	1892
Parliament	Queen	Gerrard	1882	1892
Prospect	Rose	Parliament	1882	1891
Rose	Winchester	Wellesley	1882	1891

TABLE No. 4—*Continued.*

STREET.	From	To	Date When Laid.	Date of Expiry.
Rose	Wellesley	Howard	1882	1892
St. Patrick	Huron	Spadina	1882	1892
Sullivan	Beverley	"	1882	1892
Berkeley	Wilton	Gerrard	1883	1892
Brock	King	Queen	1893	1894
Buchanan	Yonge	Terauley	1883	1892
Bellwoods	Queen	Conway (now Mansfield)	1883	1892
Charles	Church	Jarvis	1883	1892
Cameron	Queen	Bend	1883	1892
Carlton	Ontario	Easterly	1883	1892
Cameron Pl	Cameron	Vanauley	1883	1894
Clarence Sq.			1883	1894
Dorset	King	Wellington	1883	1894
Dundas	Queen	Bend	1883	1892
Foxley	Dundas	Dovercourt	1883	1892
Gladstone	Queen	Dundas	1883	1892
Howard	Parliament	Bleeker	1883	1892
High (now Grange Av.)	Spadina	Esther	1883	1892
Huron	College	Sussex	1883	1892
King	River Don	Strachan	1883	1894
Locust (now Gildersleeve Av.)	Sumach	Easterly	1883	1894
McCaul	Anderson	College	1883	1894
"	Queen	Grange Rd	1883	1894
Maple now Humbert)	Dundas	Dovercourt	1883	1894
Northcote	Queen	Saucin	1883	1894
Queen	Don River	Railway crossing	1883	1894
Ross	Cecil	College	1883	1894
Russell	St. George	Spadina	1883	1892
Sumach	Carlton	Gerrard	1883	1892
"	"	Winchester	1883	1894
St. Mary	North	Queen's Park	1883	1894
Saurin	Northcote	Lisgar	1883	1894
Woolsley	Esther	Bathurst	1883	1892
Winchester	Ontario	Parliament	1883	1894
Alexander	Church	North Mutual	1884	1894
College	Spadina	Bathurst	1884	1894
Conway (now Mansfield)	Bellwoods	Clinton	1884	1894
Division	Spadina	Huron	1884	1894
Dovercourt Rd.	Dundas	College	1884	1894
Draper	Front	Wellington Pl.	1884	1894
Fenning	Queen	Maple (now Humbert)	1884	1894
Nassau	Lippincott	Bathurst	1884	1894
Peel	Gladstone	Dufferin	1884	1894
Robert	College	Bloor	1884	1894
Stewart	Portland	Bathurst	1884	1894
Spadina	Queen	College	1884	1894
Wellesley	Parliament	Sackville	1884	1894

In connection with the above I have prepared, in tabulated form, the approximate cost of the various classes of pavements now laid in the City of Toronto, both with and without stone kerbing. The width of the roadway taken was 24 feet, that being the usual width for residential streets, admitting the construction of a 6-ft. sidewalk and a boulevard 15 ft. wide on each side of the roadway.

TABLE No 5.

Showing Cost per Square Yard of Different Classes of Pavement.

No.	Description of Pavement.	Cost per Sq. Yard.
		$ c.
1	Heavy asphalt, 6-in. concrete, 2½-in. asphalt	2 60
2	Light asphalt, 4-in. concrete, 2-in. asphalt	2 10
3	Vitrified brick on 4-in. concrete	2 25
4	Cedar block on 6-in. concrete	1 50
5	Cedar blocks on 6-in. sand	75
6	Granite setts on 6-in. concrete	3 85
7	Scoria blocks on 6 in. concrete	4 00
8	Cedar blocks on 2 layers of 1-in. boards with tar composition	1 30

TABLE No. 6.

Showing Cost per Foot Frontage of Different Classes of Pavement, with Kerbing, for a 24-Foot. Roadway.

No.	Description of Pavement.	Class of Kerbing.	Cost per Lineal Foot.	Annual Cost per Foot Frontage.	No. of Years.
			$ c.	c.	
1	Heavy asphalt, 6-in. concrete, 2½-in. asphalt	4-in. stone.	4 66	$57\frac{5}{10}$	10
2	Light asphalt, 4-in. concrete, 2-in. asphalt	"	4 00	$49\frac{3}{10}$	10
3	Vitrified brick on 4-in. concrete	"	4 20	$51\frac{8}{10}$	10
4	Cedar block on 6-in. concrete	"	3 08	$45\frac{7}{10}$	8
5	Cedar block on 6-in. sand	Wooden	1 25	$28\frac{1}{10}$	5
6	Granite setts on 6-in. concrete	4-in. stone.	6 40	$78\frac{9}{10}$	10
7	Scoria blocks on 6-in. concrete	"	6 60	$81\frac{4}{10}$	10
8	Cedar blocks on 2 layers of 1-in. boards, with tar composition	Wooden	2 06	$30\frac{6}{10}$	8
9	Cedar blocks on 2 layers of 1-in. boards, with tar composition	4-in. stone.	2 78	$41\frac{3}{10}$	8

TABLE No. 7.

Showing Cost per Foot Frontage of Different Classes of Pavements, not Including Kerbing, for a 24-Foot Roadway.

No.	Description of Pavement.	Cost per Lin. Foot Frontage.
		$ c.
1	Heavy asphalt, 6-in. concrete, 2½-in. asphalt	3 80
2	Light asphalt, 4-in. concrete, 2-in. asphalt	3 10
3	Vitrified brick on 4-in. concrete	3 30
4	Cedar block on 6-in. concrete	2 20
5	Cedar block on 6-in. sand	1 10
6	Granite setts on 6-in. concrete	5 50
7	Scoria blocks on 6-in. concrete	5 70
8	Cedar block on 2 layers of 1-in. boards, with tar composition	1 90

Work was commenced in 1890 on April 11th, in 1891 on April 6th, in 1892 on April 11th, and in 1893 on April 13th, showing a variation of only a week between the earliest and latest date.

In connection with the commencement of work, it is interesting to note the variation of date of the last snowfall during the past four years, which I obtained from Mr. Stupart, of the Toronto Observatory:

Last Storm.		Last Measurable Snow.		Last Flakes.
Date.	Quantity.	Date.	Quantity.	Date.
1890.	Inches.		Inches.	
March 28th	7.5	April 10th	0.1	April 10th.
1891.				
March 21st	3.0	May 5th	0.3	May 5th.
1892.				
February 14th	4.0	April 9th	0.2	April 10th.
1893.				
April 15th	5.5	April 15th	5.5	April 20th.

TRACK ALLOWANCE.

Owing to a dispute arising between the Toronto Railway Co. and the City as to the meaning of the term "permanent pavement," in the agreement between the City and the Company, the work of changing the old flat rail to the girder rail was not commenced until the 16th day of August. This delay necessitated shortening the time allowance given the contractors on the various contracts, and the work had to be pushed along as rapidly as the contractors and Toronto Railway Company were capable of performing it. The experience gained during the previous summer was of great advantage to both parties, who had their material and methods of working so arranged that there were none of the annoying delays which caused so much friction and gave rise to so many disputes between the Toronto Railway Co. and the contractors during the season of 1892.

The following table shows the streets upon which track allowances were changed:

TABLE No. 8.

STREETS UPON WHICH THE TRACK ALLOWANCE PAVEMENTS HAVE BEEN CHANGED IN 1893.

STREET.	From	To	Length.
Dundas	Queen	Lansdowne	6,935 feet double track.
Winchester	Parliament	Sumach	895 " " / 606 " single track.
College	Yonge	Dufferin	13,508 " double track.
Gerrard	Parliament	River	2,102 " "
Carlton	Yonge	Parliament	4,072 " "
Parliament	Queen	Winchester	3,836 " "
Queen	Yonge	River	6,215 " "
Front	Simcoe	Sherbourne	5,287 " "
York	Front	Queen	2,169 " "
Bathurst	King	Harbord	6,614 " "
Yonge	Front	King	790 " "
Bloor	Yonge	Spadina	4,658 " "
Broadview	Gerrard	Queen	2,444 " "
Church	Front	Bloor	8,536 " "
Frederick	"	King	274 " "
George	"	"	274 " "
Total			26.1 miles single track.

In addition to the above the following lengths of new pavements and tracks were laid:

STREET.	From	To	Length.
College	Dufferin	Lansdowne	2,059 feet double track.
Lansdowne	College	Dundas	370 " "
Dundas	Soraurен	Bloor	2,796 " "
High Park Av. and Howard Park Av.	Dundas	High Park	3,111 " "
Gerrard	River	Pape	4,910 " "
Total			5 miles single track.

From the above table it will be seen that the mileage of street car tracks taken up and re-laid with the girder rail was 26.1 miles of single track, and in addition 5 miles of new track were laid, leaving 17.35 miles yet to be changed. Of this last amount 11.55 miles have to be altered at the expense of the City, and 5.80 miles by the Toronto Railway Co. This last mentioned mileage has to be laid without any expense to the City, but under the supervision of the Engineer

No material changes were made in the method of paving the track allowance or laying the rails from that given in last year's report

A slight alteration, however, was made by the Railway Co. in the size of the rail base, which is now rolled to 5 inches instead of 4½ inches as previously laid. This makes an alteration in the weight of the rail, which now runs about 73 lbs. to the yard, and gives a better bearing upon the concrete base.

The following quantities and weights of material are required to build one mile of single track of street railway in this City, exclusive of wiring and poles:

TABLE No. 9.

114.714 tons of 73-lb. rails per mile single track.
5.85 " fish-plates, 17 lbs. per pair single track.
1,800 cedar ties single track.
1 ton of spikes, ¾ lb. each single track.
1 " bolts and nuts, 1 lb. each single track.

Those portions of the roadway outside the car tracks, as well as the toothing outside the outer rails, were re-paved by day labor, it being found more convenient and economical to carry out the work in this manner than to include it with the work let by contract.

In order to give some idea of the number of men employed and the time occupied to carry out the various works, I have compiled the following table, which shows the number of men, carts and teams employed upon the various works, and the actual number of working days taken to complete each work :

Street.	From	To	Total Number of Men.	Total Number of Carts.	Total Number of Teams.	Total Time.	Actual Number of Working Days.	Average Number of Men per Day.	Average Number of Carts per Day.	Average Number of Teams per Day	Width of Pavement.	Length of Street.	Average of Lineal Feet of Roadway per Day.	Class of Pavement.
											feet.	feet.	feet.	
Richmond	Victoria	Bay	860	.....	123	29	21	40.95	.....	5.86	42	852	40	Asphalt.
Earl	Sherbourne	Western terminus	284	15	84	30	21	13 52	0.71	4.00	20	634	30	"
Munn's Lane	Wellington	218 feet north	125	14	8	13	8	15.62	1.75	1.00	18	218	27	"
Czar	Yonge	North	384	46	42	37	31	12.39	1.48	1.35	20	666	21	"
Lane around old Post Office			196	5	19	22	18	10.89	0.27	1.05	8 to 12	265	14	"
Linden	Sherbourne	Huntley	322	1	60	19	12	26.83	0.08	5.00	22	585	48	"
Royce	Symington	C. P. Ry	564	.....	183	71	61	9.25	.....	3.00	33	1,575	25	Cedar on gravel.
Perth	Bloor	Royce	550	.....	79	94	66	8.33	.....	1.20	24	3,193	48	"
Churchill	Terminus of pavement	136 feet east	43	2	13	11	9	4.78	0.22	1.44	18	146	16	"
Shaw	College	Bloor	728	126	100	61	51	14.27	2.47	1.96	24	2,815	55	"
Northumberland	Ossington	Preston	66	.....	40	6	5	13.20	.....	8.00	21	262	52	"
Olive	Bathurst	Palmerston	108	.....	65	10	8	13.50	.....	8.12	24	596	74	"
Huron	Phœbe	Grange	175	20	71	28	22	7.95	0.90	3 23	24	602	27	"
Euclid Place	Euclid Ave	Eastern terminus	30	.....	14	9	8	3.75	.....	1.75	9	160	20	"
Mansfield	Manning	Clinton	80	.....	49	26	18	4.44	.....	2.72	24	293	16	"
"	Bellwoods	Grace	69	.....	40	9	8	8.62	.....	5.00	24	233	29	"
Victoria Crescent	Dunn	Jameson	229	10	65	27	24	9.54	.41	2.71	24	751	31	Cedar on plank, with tar filling.
Bathurst	King	Queen	338	48	110	18	16	21.12	3.00	6.87	16½	1,175	73	Cedar on concrete.
"	Queen	Harbord	1,513	66	281	60	51	29 66	1.30	5.51	16½	5,357	105	Brick on concrete.
Bloor	Yonge	Spadina	2,623	.....	174	76	65	40.35	.....	2.67	16½	4,658	71	Stone on concrete.
Broadview	Queen	Gerrard	573	.....	154	27	24	23.87	.....	6.42	16½	2,509	104	Cedar on concrete.
Gerrard	River	Pape	1,239	.....	417	49	41	30.22	.....	10.17	16½	4,910	119	"
"	"	Parliament	637	11	194	26	23	27.70	0.48	8.43	16½	2,102	91	"
Parliament	Queen	Gerrard	1,417	.....	120	36	31	45.71	....	3.87	16½	2,490	80	Asphalt.
"	Carlton	"	421	.....	108	16	14	30.07	.....	7.71	16½	880	63	"
"	"	Winchester	283	.....	96	17	15	18.87	.....	6.40	16½	466	31	"
Winchester	Parliament	Sumach	1,388	53	303	36	30	46.26	1.76	10 10	34	1,512	50	Asphalt. Street car track and local improvement.
Carlton	"	Yonge	1,680	2	330	39	24	70.00	0.08	13 75	16½	4,072	169	"
College	Yonge	McCaul	1,138	79	62	39	34	33.47	2.32	1.82	16½	2,806	82	"
"	Bathurst	"	1,617	15	191	36	31	52.16	0.48	6 16	16½	3,933	126	"
"	"	Clinton	671	46	25	45	40	16.77	1 15	0.62	16½	1,693	42	Brick.
"	Concord	"	691	58	9	42	34	20.32	1.70	0.26	16½	2,680	78	"
"	"	Dufferin	679	89	174	60	48	14.14	1.85	3.62	16½	2,377	50	"
Jameson	Dundas	College	725	.....	28	48	43	16.86	.....	0.65	16½	2,499	58	"
College	Jameson	Dufferin												
York	Queen	Front	1,412	67	102	31	27	52.30	2.48	3.77	16½	2,066	76	Asphalt.
Front	Church	Simcoe	1,867	166	79	66	58	32.19	2.80	1.36	16½	3,215	55	Stone. Street car track.
"	"	Frederick	739	65	104	41	32	23.09	2.03	3.25	16½	1,594	49	" "
Church	Front	Queen	884	42	13	42	36	24.55	1.17	.36	16½	1,567	43	Stone on concrete.
"	Queen	Bloor	5,993	21	382	83	71	84.41	.30	5 38	16½	6,656	93	"
Queen East	Yonge	River	3,101	14	236	30	26	119.27	0.54	9.08	16½	6,215	239	Asphalt on concrete.
Yonge	Front	King	198	8	12	32	21	9.43	.38	.57	16½	792	37	Stone on concrete.
Howard Park	Roncesvalles	Dundas	218	.....	21	17	15	14.53	.....	1 40	16½	842	40	Cedar on concrete.
High Park	"	High Park	1,035	.....	332	81	70	14.79	.....	4.74	40	2,269	32	" Street car track and local improvement.
Dundas	Queen	Arthur	952	.....	41	27	20	47.60	.....	2.05	16½	1,937	96	Asphalt on concrete.
"	Arthur	Jameson	1,250	102	445	45	34	36.76	3.00	13.09	16½	4,951	145	Brick on concrete.
"	Sorauren	Bloor	1,312	.....	378	83	69	19.01	.....	5.48	42	2,796	40	Cedar on concrete. Street car track and local improvement.
Total			41,407	1,191	5,976	1,750	1,434	233.31	35.11	202.95	.....	94,865	2,910	

The figures shown in the above table are for men and teams employed in excavating and re-paving the roadways indicated, and are exclusive of all men employed by the Toronto Railway Co. to lay track. For this latter purpose an average of 41 men per day and 2 foremen were employed. The most rapid track-laying was when 1¼ miles of track were laid in one day, and shows what can be effected by proper organization and good management.

STONE SETT PAVEMENTS.

Whilst re-laying the track allowances, 3.743 miles of stone and granite sett pavements were taken up and the blocks re-cut and then re-laid upon a concrete foundation. The contractors were allowed to use all the stone within the track allowance (16 ft. 6 in.), which upon being re-cut was found to be fit to re-lay on the new concrete foundation. The majority of these stones were from 7 to 8 inches in depth, and had to be cut so as not to exceed from 5½ to 6 inches in depth. Where additional stone was required the contractor had to supply it at his own expense. The cost of this work averaged $1.56½ per sq. yard, including the concrete foundations. This price was considerably below my estimate for the work, and I do not think that we are likely to have such cheap work in future, as the contractors claim they lost money by under-estimating the cost of re-cutting. I think that this reduction in the size of the stone will improve the wearing qualities of the pavement, causing it to wear more evenly than under the old system. In New York it was found that stone blocks varying in height from 7 to 8 inches were not at all satisfactory, the wear being very uneven. In London and Liverpool, on the other hand, which are probably the best paved cities in the world, a variation of only ¼ inch in height is allowed. This of necessity adds to the cost, but is more than counterbalanced by the increased life of the pavement.

BROKEN STONE ROADWAYS.

The only new roadway of this class constructed during the past year was Centre Road or South Drive, Rosedale.

The surface of the ground was excavated to a depth of 11 or 12 inches, and thoroughly rolled with a 10-ton roller until a compact sub-grade was obtained, upon which a layer of large stones was placed on end by hand, and the interstices filled with small pieces of granite: the whole was then rolled until the stone formed a true sur-

face. Upon this a layer of broken granite was laid and rolled, the surface and binder being composed of fine granite screenings. The roadway was rolled longitudinally, beginning at the kerb, and the final rolling being upon the crown of the roadway. This rolling was continued, and the roadway thoroughly sprinkled with water until no impression could be made with a horse roller, 3 ft. 6 in. in diameter and 4 ft. 6 in. in width, loaded to weigh 10 tons, and giving a pressure of 433 lbs. per lineal inch of roller. No loam or sand was allowed to be mixed with the stone, which was clean and broken to pass through a 1½-inch ring. It was necessary to use a horse roller for this work, owing to the fact that a steam roller of sufficient weight could not be obtained in this City.

When completed, the residents expressed themselves as well satisfied with the roadway, which presents a neat and even surface, and well adapted for roadways where there is only light travel. The cost is greater per square yard than cedar block paving, and the disadvantages are chiefly that repairs must be made annually, and that in wet weather the granite grinds into mud and is dusty in summer. On the other hand, the absence of noise from passing vehicles, and the good footing afforded to horses, makes it a desirable class of roadway in residential streets, especially where the houses are built at some distance back from the roadway so that the residents are not annoyed by the dust.

BRICK PAVEMENTS.

The first brick pavements laid in this City were constructed on Dundas, Bathurst and College Streets, between the street car rails. In this position they will be subjected to the most severe test that any pavement can receive, the gauge of the street car tracks being 4 ft. 10⅝ in., or almost identically the same as the width between the wheels of carriages and wagons. That portion of roadway between the rails is used to a greater extent by the drivers of vehicles than any other part of the roadway, advantage being taken of the smooth surface offered to the wheels by the head of the rails. It was anticipated at one time that when the electric cars displaced the horse car service vehicles would be compelled to use the sides of the roadway in preference to that portion on which the rails are laid. Such, however, has not turned out to be the case, as the drivers of heavy wagons still show a preference for the car tracks. The frequent necessity of turning out to avoid the street cars causes that portion of pavement

GRADING BATHURST STREET.

nearest the rail to be ground and chipped, and will eventually wear into a rut. In order to test the comparative strength of brick and scoria to resist this rutting process, Dundas Street and a portion of College Street were laid with only brick inside the rails, whilst the remaining portion of College Street, from Dundas to Bathurst, was laid with a single row of scoria blocks on the inner side of each rail, set so that the chamfer of the block was at the same elevation as the lip of the rail; this left the head of the block the same height as the head of the rail, and gives a smooth, hard surface for the wheels of vehicles. Up to the present time there has been no sign of wear on either. These brick pavements were constructed by placing the bricks on edge on a sand cushion laid upon a concrete foundation. They were thoroughly pounded with wooden rammers to a firm bearing, and the spaces between the bricks were then filled with a grout of Portland cement and sand on Dundas Street and on College Street between Lansdowne and Dufferin. On that part of Bathurst Street between College and Queen, and on College between Bathurst and Dufferin, a paving pitch filling was used. One reason for adopting the pitch filling for these latter streets in preference to Portland cement grout was owing to the difficulty of keeping vehicles from being driven over the unfinished roadway. Where Portland cement is used to grout the bricks it is absolutely necessary, in order to secure a good bond, to prevent travel of any kind passing over the surface of the pavement for at least five or six days.

I regret that part of the Bathurst and College Street work was laid so late in the season, and I expect that it will be necessary to re-lay some portions of these works. The contractors have, however, to maintain this work in perfect order for a space of five years from date of completion, and any defects in the pavements consequent upon its construction in cold weather will show themselves long before that time has expired, and have to be made good by the contractors at their own expense.

The bricks used in these pavements were all imported from the United States, there being none manufactured in Canada which came up to the requirements of the specifications. It is unfortunate that the home manufacturers have not yet been successful in producing a first-class paving brick suitable for use in this City, as I believe the demand for this class of pavement will increase yearly, owing to the good foothold it affords to horses, the ease with which it can be

cleaned and repaired and its non-absorbent qualities, making it preferable to either cedar block or broken stone.

In order to ascertain the relative merits of the various bricks, they were subjected to tests for absorption, abrasion and the specific gravity was taken according to a formula inserted in the specifications. The specific gravity test was adopted for the purpose of ascertaining the homogeneity of the samples under examination, as this indicates at once bricks in which there were cavities or cracks not appearing on the surface. In addition to this some tests for transverse strength were made at the School of Practical Science. The term "vitrified brick," in connection with this class of paving material, I consider a misnomer. A really vitrified brick—that is, one like glass—would be too brittle for paving purposes. What is required is a tempered or annealed brick, one which has been almost but not quite fused in the kiln and then gradually cooled so as to toughen or anneal it, makes a more lasting pavement, and is not so liable to fracture under the calks of horses' shoes.

The absorption tests were conducted as follows:

The samples to be tested were first thoroughly dried by placing them in an oven and keeping them at a temperature of 212 degrees Fahrenheit for a length of time dependent upon the size of the piece under examination. The brick or portions of brick were then weighed and afterwards immersed in water for 72 consecutive hours, after which they were taken out and the surface water carefully removed, the specimen being again weighed and the percentage of absorption calculated.

For the abrasion test the bricks were first weighed and measured, then placed in a foundry rattler with 200 lbs. of foundry shot. The rattler was revolved at a rate of 30 revolutions per minute for 2,000 revolutions, when the bricks were taken out and re-weighed, and the resulting loss of weight calculated as well as the loss in cubic inches for every square inch of surface.

The specific gravity was determined by the following formula: specific gravity $= \frac{W}{X - Y}$ where W = weight of specimen free from moisture before immersion, and X = weight of same in air after 72 hours' soaking, and Y = weight of same in water.

The following table shows the results of the various tests made:

LAYING CONCRETE FOUNDATION FOR BRICK PAVEMENT ON BATHURST STREET.

No. of Specimen.	Specific Gravity.	Abrasion.				Absorption.				Remarks.
		Original Weight.	Weight after 2,000 Revolutions, at 30 per Minute.	Percentage of Loss by Weight.	Percentage of Loss per Square Inch of Surface.	Weight Before Immersion.	Weight After Immersion.	Percentage of Increase.	Length of Time Immersed.	
		lbs.	lbs.	lbs.	cub. ins.	lbs.	lbs.	lbs.	days.	
1	2.46	39	33	15.4	0.08	24.7	25.22	2.10	3	6 bricks, Coleman Hamilton Co., Ohio, from Clark & Connolly's work on College St.
2	2 54	48	42	12.5	0.084	30 333	31.998	5.47	3	Mimico brick, average of 6 bricks.
(	2.50	48	34.5	28.1					3	" " "
3	1.90					26.25	29.42	12.09	3	Canadian re-pressed brick, maker unknown.
4	1.95					20.86	22.65	8.58	3	" " "
5	2.37	20.75	17.75	14.40					3	3 bricks from Mr. Farquhar (New York brick).
6	2.29	13.82	10.24	25.90					3	2 " E. B. Morse (Ohio brick).
7	2.41	7.12	6.65	6.60	.051	7.06	7.12	0.87	3	Canton shale, Ohio, average from 6 bricks.
8		13.88	12.75	8.13						2 bricks from E. B. Morse (Ohio brick).
9		13.72	12.06	12.09						2 re-pressed bricks from E. B. Morse (Ohio brick).
10	2.34	13.31	11.81	11.30						2 bricks from Knowlton (Penn.).
11	2.34	10.62	8.75	17.60						" " " smaller in size than No.10
12	2.40	7.31	6.43	12.03						A shale brick from Ohio (Farquhar).
12*a*	2.30	6.25	5.50	12.00		4.90	5.00	2.00	4	Massilon Brick Co. (a fire-clay, not vitrified .
12*b*	2.23	6.75	6.06	10.23						Well vitrified, same maker as No. 12*a*.
12*c*	2.23	6.75	5 81	13.92						" " "
13	2.38	7.45	6.59	11 54		6.16	6.19	0.48	3	Mr. Farquhar (Ohio brick).
14	2.40	6.95	6.58	5.22						Iron rock, Royal Brick Co., Ohio.
15	2.47	7.59	7.14	5.92						Cleveland (edges on this brick bevelled).
16	2.24	41.34	38.34	7.26	.061	6.45	6.64	2.90	3	Average of 6 bricks, Massilon Brick Co.
17	2.22	39.90	35.40	11.30	.069	6.469	6.625	2.35	3	" " " "
18	2.22	13.75	12.75	7.27				2.40		One of these bricks had a flaw. They were taken off College Street. Massilon Brick Co.
19	2.24	6.92	6.62	4.33						This was a picked specimen, Massilon Brick Co.
20		62	59.75	0 044						This test was made on 4 scoria blocks. After an additional 2,000 revolutions, or 4,000 in all, they weighed 59 lbs., being a total loss of 3 lbs., or .0484 p. c.
21		65	64.25	0.011						Test made on 4 red granite setts. After an additional 2,000 revolutions the 4 weighed 63.50 lbs., or .023 p. c.

LAYING BRICK PAVEMENT ON BATHURST STREET.

Bricks from No. 1 sample were put in the rattler with grey granite setts, and given 2,000 revolutions, with a resultant loss on granite of 2.12 per cent. of weight, and on the brick of 11.2 per cent. Samples of No. 1, showing grey fracture, and No. 1, showing light yellow fracture, were also tested together, and the grey lost 14.8 per cent., or 0.1070 per square inch of surface, whilst the yellow lost 15.4 per cent. of weight, or 0.1113 per square inch of surface, showing practically no difference in this test.

No. 16 was used on College Street by contractor VanVlack, between Dufferin and Clinton Streets.

The Canton shale was used by Messrs. Shannon & Whillans, on College and Dundas, and Bathurst Street was paved by Messrs. McKnight & Co. with bricks from Canton, Ohio.

No. 1 were used on College Street between Lansdowne Avenue and Dufferin, and on Lansdowne Avenue between Dundas and College, by Messrs. Clark & Connolly.

The test for transverse strength was made by placing the bricks on edge upon bearings 6 inches apart and then applying a load halfway between supports.

The modulus of rupture was then determined by the usual formula for rectangular solid cross sections, viz.:

$$f = \frac{3\,w\,l}{b\,h^2}$$

Where w is the breaking load, l = ½ the span, b = horizontal width, and h = vertical depth.

Samples of brick No. 1 were tested in the above manner with the following results:

Sample No. 1 (*a*)	f = 1902
" (*b*)	f = 2250
" (*c*)	f = 1025
" (*d*)	f = 2869
Sample No. 2, Mimico brick	f = 1474
Sample No. 13, Ohio brick, (*a*)	f = 1718
" " (*b*)	f = 2950

LOCAL IMPROVEMENTS.

The works performed under the local improvement system, together with the amount expended upon them, their mileage and the name of contractor doing the work, will be found in Table No. 14 forming part of this report.

In connection with the local improvement work there has been a marked change in the demand for sidewalks under this system. Whilst in 1891 there were 23 contracts carried out and assessed against the various properties benefited thereby, in 1892 there were only 7 contracts let by the City, and 10 pieces of sidewalk were laid by private contract: while in 1893 there were 3 contracts for stone and concrete sidewalks let by the City and 16 private contracts. These private contracts are carried out under the supervision and inspection of this Department, and the property owner before whose property the sidewalk is laid pays all charges for inspection, and the contractor is paid by the property owner personally upon certificate being issued from this office that the work has been carried out in accordance with the City specifications. This plan has many advantages to commend it, as it saves the cost of making assessments, issuing debentures, and collecting the taxes thereon. Whilst the property owner gets the work done quite as cheaply as under City contract, the cost of inspection is, however, somewhat higher than where a large area of sidewalk is laid under the local improvement plan.

The following table shows the various classes of roadways in the City of Toronto from 1881 to 1893:

TABLE No. 12.

SHOWING THE DIFFERENT CLASSES OF ROADWAYS AND MILEAGE OF THE SAME, FROM 1881 TO 1893.

YEAR.	Cedar Block.	Stone and Scoria.	Asphalt.	Wood on Concrete.	Macadam.	Unpaved.	Cedar with Asphalt on Track Allowance.	Cedar Block with Brick on Track Allowance.	Macadam with Stone Setts on Track Allowance.	Total Mileage.
1881	3.51	0.03			50.92	62 39				116 85
1882	13.41	0 03			48.28	55.13				116.85
1883	26.30	0 03			54.57	54.07				135 57
1884	33.76	0.25			52.32	76.77				163 10
1885	39 84	0 25			50.17	75.98				166 24
1886	43.99	0.36			47.36	72.18				168.89
1887	64 11	0.35	0.07		45.14	59.21				168 89
1888	79.55	0.36	0.25		42 76	49.87				172 79
1889	92.39	0.36	3 36		38.65	107.43				242.19
1890	100 57	0.36	5.08		36.63	90.55				242.19
1891	116.83	0.59	6.66	0.49	36 39	89.41				250.40
1892	116.86	0.65	10.49	0.49	36.98	84 89	2 35			252.71
1893	112 19	0.79	11.28	0.49	34.98	82.05	7.06	3.97	0.54	253.35

In addition to the roadways included in the above table there are about 83 miles of lanes, of which only 2.74 miles are paved. The property owners abutting these lanes should be urged to have them paved as rapidly as possible, especially in the central and crowded part of the City.

Where concrete foundations have been laid under the roadways the sewers have been previously examined, and the water, gas and electrical connections put in thorough order. The property owners were previously notified to have all their private drain connections made, so that there should be no possible disturbance of the pavement after it is once down. Unfortunately water pipes will burst and gas pipes leak, and in some cases it has been necessary to cut through the new pavements to make repairs. Although, in justice to the companies who have the right to tear up the City pavements, I must say that every precaution is taken to insure the material excavated being properly replaced and the pavement being restored to its original condition, yet there is always a certain amount of work caused by these disturbances which has to be done at the City's expense, and I would most respectfully suggest that in future when any company desires to obtain a franchise which requires openings or excavations in the public thoroughfares, it should be drawn up in such a manner that all repairs shall be made under the City Engineer's orders, and the cost paid by the corporation enjoying such privilege.

TRINIDAD ASPHALT PAVEMENTS.

Owing to the rapid increase and growing demand for Trinidad asphalt pavements in this City, and the difficulty of obtaining reliable information as to the effect of weather and climate upon the different kinds of asphalt laid, and at the same time with a view of discovering why some of the asphalt pavements already laid were showing signs of cracking and disintegration under travel, I considered it advisable to have a continuous record kept of the asphalts and residuum oils used in the manufacture of the different asphalt pavements. Accordingly from time to time samples of the refined asphalt were taken from the stock on hand at the works of the various asphalt companies. Samples of their oils were also taken whenever new consignments were received. These samples of oils were carefully analyzed and examined for paraffines and other substances likely to be injurious to the pavement, also to ascertain their susceptibility to changes of tem-

RECORD OF SHEET ASPHALT LAID ON RICHMOND ST., VICTORIA TO BAY, BY CONSTRUCTING AND PAVING CO. WORK STARTED MAY 30, 1893; FINISHED JUNE 27, 1893.

Refined Asphalt.	Aspr. Cement. No.	Aspr. Cement. Penetration.	Residuum Oil. Flash.	Residuum Oil. Flow.	Residuum Oil. Susceptibility to Change of Temperature.	Residuum Oil. Dist'l at 400 F. for 7 hrs.	Residuum Oil. Paraffine	Surface Mixture. No.	Surface Mixture. Dust.	Surface Mixture. Bitumen.	Remarks.
Analysis. I. II.											
Bitumen 55.50 55.41					Fair.	12.95	None.	3	37.49	9.06	
Inorganic matter..... 38.37 38.31	1	45				12.37					
Organic matter 6.13 6.28	2	47								Organic matter, 0.9	
Petrolene { P. c. to total asphalt....33.97 32.98	3	47							Lime, 20.82		
Petrolene { P. c. to total bitumen .61.20 59.7	4	48									
	5	43									
Standard Lake contains about 70% to total bitumen.	6	50									
Quality, "Land Pitch."		Penetration too low, otherwise the mixture is good.									

RECORD OF SHEET ASPHALT LAID ON EARL ST., BY TRINIDAD ASPHALT CO. WORK STARTED JUNE 13, 1893; FINISHED JULY 13, 1893.

Specific gravity at 77 F. = 1.4399	7	51			Fair.	5.34	Trace.	4	32.99	9.15	
Per cent. of flow 32	8	53				8.25		5	34.87	9.37	From Warren-Scharf pavement at junction with Sherbourne St.
Softens ..... 197° F.	9	51				4.64		6	34.13	7.81	
Flows ..... 230 F.	10	51						7	28.70	10.03	
Petrolene = 50.50% of bitumen.	11	52						8	26.35	9.18	
	12	55						9	.....	9.86	
Quality, "Land Pitch."		Penetration too low.						10	35.01	9.60	$CaCo_3$ in surface mixture average 20.5
								11	37.95	9.60	
								12	35.41	9.41	
								13	34.24	9.43	

RECORD OF SHEET ASPHALT LAID ON WINCHESTER STREET, BY CONSTRUCTING AND PAVING CO. WORK STARTED AUGUST 1, 1893; FINISHED AUGUST 24, 1893.

Analysis.								14	34.79% / 32.51	8.87 / 8.75	
Total bitumen 52.53	13	64	330	61° F.	Quite viscous at 4° C.	6.41	None.	15	35.60	10.10	
Organic matter non-bitumen . 8.15	14	60				4.83		16	35.68	9.80	
Inorganic matter 39.32	15	57	(Closed Tester.)					17	37.17	9.47	
100.00	16	60						18	35.29	9.09	Oil is good.
	17	56						19	36.56	9.74	
Petrolene 34.22	18	65						20	35.65	8.67	NOTE. With the same gasoline standard lake held over 70 petrolene in bitumen.
" per cent. of bitumen soluble in gasoline. 65.14	19	60						21	33.84	9.64	
	20	65						22	33.85	9.81	
Specific gravity at 77. F. = 1.4326	21	63						23	36.12	9.73	
Softens ..... 197 F.	22	63						24	37.95	10.90	
Flows ..... 220 F.	23	60						25	35.55	9.24	
Flow per cent..... 32.1	Average 61.2							26	34.60	8.66	
Distillate at 400 F. for 7 hrs. = 3.22		Penetration about 10 too low.						27	31.42	10.00	
								28	36.61	10.19	
Quality, "Land Pitch" (medium).								Average 35.20		9.48	

RECORD OF SHEET ASPHALT LAID ON DUNDAS ST., BY CONSTRUCTING AND PAVING CO. WORK STARTED AUGUST 16, 1893; FINISHED SEPTEMBER 11, 1893.

Specific gravity 1.4326	27	55	330 F.	61	At 4 C. viscous.	6.41%	None.	30	32.41	9.47%	
Softens ..... 197 F.	28	57				4.83		31	30.87	9.90	
Flows ..... 220 F.	29	.....						32	.....	9.67	
Flow per cent..... 32.1	30	60						33	.....	9.47	
	31	60						34	.....	9.30	
Quality, "Land Pitch," same lot as was used on Winchester St.	32	57						35	.....	10.06	
	33	64						36	.....	9.19	
	34	57						37	.....	9.22	
	35	60						38	.....	9.09	
								39	.....	8.52	
								40	.....	8.22	
								41	.....	8.82	

RECORD OF SHEET ASPHALT LAID ON CZAR ST., BY TRINIDAD ASPHALT CO. WORK STARTED AUGUST 18, 1893; FINISHED SEPTEMBER 25, 1893.

Analysis.											
Bitumen 53.32	44	48			Fair.	5.34%	Trace.	49	.....	8.90 / 8.02	
Inorganic matter 38.70	45	49				8.25		50	.....	8.88	
Organic matter non-bitumen .. 7.98	46	52						51	.....	9.22	
Petrolene = 54.01 of bitumen.	47							52	.....	8.72	
Specific gravity at 77 F. = 1.4428	48							53	19.06%	9.16	
Per cent. of flow 38.6	49							54	18.34	8.68	
Softens at ..... 230 F.											
Flows at ..... 275 F.											
Quality, "Land Pitch" (poor).											

RECORD OF ASPHALT PAVEMENT LAID ON CARLTON ST., YONGE TO PARLIAMENT, BY CONSTRUCTING AND PAVING CO. WORK STARTED AUG. 20, 1893; FINISHED SEPT. 28, 1893.

The first part was constructed with "Land Pitch," same lot as on Dundas Street, but the work was finished with "Lake."	36	57	390° F.	.....	At 38° F. viscous.	2.29	Trace.	42	.....	7.99	*No. 42 Surface Mixture Complete Analysis.*
	37	61		74° F.	" 60° F. semi-vis.	2.59		43	.....	8.48	
	38	49			" 74° flows.			44	.....	8.29	Bitumen 7.99
	39	48			" 100° approaches liquidity.			45	.....	8.76	Silica and organic matter..... 70.19
	40	50						46	.....	9.22	Iron and alumina . 2.68
	41	51						47	.....	8.92	$CaCo_3$ 18.73
	42	50						48	.....	8.10	99.59
	43	47									
	54	62									
		Penetration too low and irregular.									

RECORD OF SHEET ASPHALT LAID ON COLLEGE ST., YONGE TO MCCAUL, BY TRINIDAD ASPHALT CO. WORK STARTED AUGUST 21, 1893; FINISHED SEPTEMBER 28, 1893.

Analysis.										
Bitumen 53.32%	50	58	390° F.	74 F.	Between 200-290° F. much violent ebullition was noticed.	4.98	Trace.	55	.....	8.22
Inorganic matter..... 38.70	55	47				4.22		56	.....	9.96
Organic matter, non-bituminous 7.98	56	49						57	.....	8.22
	57	62						58	.....	9.50
Petrolene ... 54.01 of bitumen.	58	68						59		8.84
Specific gravity at 77° F. 1.4428	59	65						60		8.54
Per cent. of flow 38.6	60	78						62		11.94
Pitch Lake 100	61	80								
Softens ..... 230° F.	62	79								
		Penetration much too irregular.								

Record of Asphalt Pavement laid on Carlton St., Yonge to Parliament, by Constructing and Paving Co. Work Started Aug. 29, 1893; Finished Sept. 28, 1893.

The first part was constructed with "Land Pitch," same lot as on Dundas Street, but the work was finished with "Lake."

36	57	Penetration too low and irregular.	390° F.	74° F.	At 38° F. viscous.	2.29	Trace.	42	..	7.99	
37	61				" 60° F. semi vis.	2.59		43	.....	8.48	
38	49				" 74° flows.			44	.....	8.29	
39	48				" 100° approaches liquidity.			45	.....	8.76	
40	50							46	.....	9.22	
41	51							47	.....	8.92	
42	50							48	.....	8.10	
43	47										
54	62										

No. 4 Surface Mixture Complete Analysis.

Bitumen	7.99%
Silica and organic matter	70.19
Iron and alumina	2.68
$CaCo_3$	18.73
	99.59%

Record of Sheet Asphalt laid on College St., Yonge to McCaul, by Trinidad Asphalt Co. Work Started August 24, 1893; Finished September 28, 1893.

Analysis.

Bitumen	53.32%
Inorganic matter	38.70
Organic matter, non-bituminous	7.98
Petrolene	54.01% of bitumen.
Specific gravity at 77° F.	1.4428
Per cent. of flow	38.6
Pitch Lake	100
Softens	230° F.
Flows	275° F.

Quality, "Land Pitch," poor.

50	58	Penetration much too irregular.	390° F.	74° F.	Between 200-290° F. much violent ebullition was noticed.	4.98% 4.22	Trace.	55	.....	8.22
55	47							56	.....	9.96
56	49							57	.....	8.22
57	62							58	.....	9.50
58	68							59	.....	8.84
59	65							60	.....	8.54
60	78							62	.....	11.94
61	80									
62	79									
63	65									

Record of Sheet Asphalt laid on Parliament St., Queen to Carlton, by Warren-Scharf Co. Work Started August 22, 1893; Finished September 23, 1893.

				60° F.	At 32° F. viscous.	4.03% 4.27	Trace.		CaCo	
51	71°	Penetration good.						70	19.97%	7.47 7.57
52								71	.....	7.32
53	76°							72	.....	7.85
								73	.....	8.10
								81	.....	7.74
								82	.....	8.43
								83	.....	9.34
									Dust	
								85	32.45	9.01
								87	.....	8.32

Specific gravity at 77° F. = 1.3939
Per cent. of flow 76.1
Softens ..... 185° F.
Flows ..... 204° F.
Distillate at 400° F. for 7 hours, 3.3%

Analysis: Bitumen, 55.70% (by diff.); Other organic matter, 8.10%; Inorganic matter ... 36.20%

Quality, "Pitch Lake" asphalt.

Record of Sheet Asphalt laid on College St., McCaul to Bathurst, by Constructing and Paving Co. Work Started August 30, 1893; Finished October 4, 1893.

Specific gravity at 77° F. = 1.3960
Per cent. of flow = 70
Standard lake = 100
Softens ..... 180° F.
Flows ..... 200° F.

Quality, "Lake Pitch."

64	63°		340° F.		Fair.	4.22%	Trace.	65	.....	9.42	
65	66°							66	.....	8.89	
								67	.....	6.73	
								68	.....	10.28	
								88	32.78%	10.04	Surface mixture irregular, caused by careless mixing.
								90	.....	9.96	
								92	34.26%	8.82	
								93	.....	10.22	
								94	.....	11.16	

Record of Sheet Asphalt laid on Queen St., Yonge to River, by Constructing and Paving Co. Work Started Septemeer 13, 1893; Finished October 13, 1893.

Specific gravity at 77° F. = 1.3960
Per cent. of flow 70%
Standard lake 100
Softens at ..... 180° F.
Flows ..... 200° F.
Per cent. of bitumen petrolene 60.14

With same gasoline standard lake gave about the same percentage.

Quality, "Good Lake."

66	54	Penetration too low; mixture regular.	340° F.	60° F.	Fair.	4.22%	Trace.	95	.....	9.56
67	...							96	.....	9.39
68	53							97	.....	9.50
69	56							98	.....	9.80
70	57							99	.....	9.08
71	52							100	.....	9.22
72	57							101	.....	9.14
73	56							102	.....	8.49
81	54							103	.....	8.88
82	56							104	.....	9.62
83	56							105	.....	10.60
								106	.....	9.52
								107	.....	11.40
								108	.....	10.12
								109	.....	9.52
								110	.....	10.28
								111	.....	10.28
								112	.....	9.68
								113	.....	8.98
								114	.....	10.36
								115	.....	9.48
								116	.....	9.92
								117	.....	10.42
								118	.....	9.80

Record of Sheet Asphalt laid on York St., Front to Queen, by Trinidad Asphalt Co. Work Started September 18, 1893; Finished October 18, 1893.

Analysis.

Bitumen 53.32%
Inorganic matter 38.70
Organic matter 7.98
Petrolene = 54.01% of bitumen.
Per cent. of flow 38.6
Pitch Lake 100
Softens ..... 230° F.
Flows ..... 275° F.

Quality, "Poor Land."

74	60		325°		Very fair.	3.69	None.	126	.....	9.56
75	59							127	.....	8.58
76	67							128	.....	9.38
77	63							120	.....	9.36
78	65							123	.....	9.02
79	62							129	19.54	8.82
								133	21.84	10.12
								135	.....	9.16

Record of Sheet Asphalt laid on Linden St., by Constructing and Paving Co. Work Started October 3, 1893; Finished October 21, 1893.

Specific gravity at 77° F. 1.3960
Flow per cent 70
Standard Lake 100
Softens at ..... 180° F.
Flows at ..... 200° F.

Quality "Lake Pitch"

85	49	Penetration very irregular.	340° F.		Fair.	4.22	Trace.	136	.....	9.88
85	62°							137	.....	10.22
								138	.....	9.74
								139	.....	9.78

perature. The refined asphalt was examined to discover whether it was land or lake asphalt. Samples of the asphaltic cement were taken several times a day when the paving mixtures were being prepared, and subjected to a test for consistency. Finally, samples of the finished pavement were taken from the roadway and examined as to the admixture of asphaltic cement and sand, in order to ascertain the regularity of the mixture.

From the foregoing examinations it will be seen that the penetration test shows great irregularity in the asphaltic cement used in the surface mixtures upon some of the roadways, notably College Street, Yonge to McCaul, and Carlton Street, Yonge to Parliament. This is caused either by a variation in the quantity of oil added to the asphalt to form the asphaltic cement or by want of thorough mixing. The attention of the companies upon whose contracts this occurred was called to these irregularities, and steps will be taken to try and guard against them in future. An irregular cement must form an irregular surface mixture, and with wear the pavements will become wavy and lumpy upon the surface, eventually wearing into holes where water will lodge and finally destroy the pavement.

It is to be regretted that a regular system of analysis and examination of the asphalt and oils used in the manufacture of asphalt pavements has not been kept since they were first laid in Toronto, so that the experience gained by success or failure in this class of work would be a guide for similar work in future. The proper proportions in which to mix the various ingredients forming this class of pavement varies so much in different localities, according to the climate amount of travel, quality and properties of the residuum oils and asphalt used, that what is suitable in one locality is not at all a fair criterion for use in another, and mixtures which may be perfect successes in one city may turn out failures in another.

During the month of June, acting under your instructions, I proceeded to Washington to examine and report on the relative merits of Trinidad and Bermudez asphalts, and subjoined is a copy of the report which I submitted to you on my return :

TORONTO, June 6th, 1893.

E. H. KEATING, ESQ.,
City Engineer, Toronto:

Re BERMUDEZ ASPHALT.

DEAR SIR.—In reference to the attached communication from the Committee on Works, regarding Bermudez asphalt, I beg to state that I have made an examination of the samples submitted to me by Mr. Guelich, which he states are imported from Bermudez, in Venezuela, and I find them to be constituted as follows:

No. 1, marked "Crude Bermudez Asphalt," contains:

Water	7.64	per cent.
Bitumen and organic matter	88.81	"
Inorganic matter	3.55	"
	100.	"

A second piece of the crude asphalt was then examined, after the moisture had been carefully driven off, with the following result:

Bitumen and organic matter	94.97	per cent.
Inorganic matter	5.03	"
	100.	"

An analysis of the inorganic matter showed it to consist of 65.60 per cent. of silica and clay and about 34 40 per cent. of soluble salts.

The second specimen, marked "Refined Bermudez Asphalt," was next examined, and resulted as follows, from an average of three examinations:

Specific gravity at 77 deg. Fah., 1,079. Flows at about 100 deg. Fah.

Bitumen	96.09	per cent.
Inorganic matter	2.76	"
Non-bituminous organic matter	1 15	"
	100.	"

The amount of bitumen soluble in petroleum naphtha was found to be 76.49 per cent., while the percentage of the total amount of bitumen soluble was 77.52.

The asphalt was found to be singularly adhesive, rather more so than the best Trinidad.

For convenience of comparison, I give you an analysis of the best refined Pitch Lake asphalt obtainable from the Island of Trinidad:

Specific gravity at 77 deg. Fah., 1,377. Flows at about 198 deg. Fah.

Bitumen	57.47	per cent.
Organic matter, non-bituminous	7.05	"
Inorganic matter	35.48	"
Bitumen soluble in petroleum naphtha	41.59	"
Per cent. of total bitumen soluble	72.37	"
Viscosity	Adhesive.	

By comparing these last two results it will be seen that the specific gravity of the Bermudez is very much lower than the Trinidad. I consider this to be due chiefly to the small quantity of impurities which prevail in the Bermudez, the amount being only about 3.91 per cent., as compared with 42.53 per cent. in the Trinidad asphalt.

The amount of bitumen in the refined Bermudez amounts to 96 per cent. of the total mass, while in the Trinidad it is only 57.5 per cent.; and while the refined Bermudez contains only 2.76 per cent. of inorganic impurities, the Trinidad contains about 35.5 per cent. As, however, there has to be added sand and carbonate of lime to make up the paving mixture, I cannot see that this is any advantage to the Bermudez, excepting that a smaller quantity of asphaltic cement would be required in the mixture. It is claimed that the natural mixture of the various impurities in the Trinidad asphalt is not a detriment, but, on the contrary, the natural mixture is preferable to anything that can be made artificially, and is one of the reasons of the Trinidad pavement lasting as well as it does.

The Bermudez company contend that the artificial mixing can be done quite as well, if not better, than the natural, and that while the Bermudez is almost impervious to water, the Trinidad will disintegrate very rapidly when water settles upon it.

The Bermudez asphalt contains only 1.15 per cent. of non-bituminous organic matter, while the Trinidad contains 7 per cent. This I consider a decided advantage in favor of the Bermudez. The Bermudez asphalt contains more light oils, volatile at a lower temperature, is softer, more pliant and would require a smaller quantity of residuum oil to be added to it to make the asphaltic cement. This is

a decided advantage, but unless care is taken in the refining process to remove some of the lighter of these volatile oils, there would probably be a difficulty in making the cement of a uniform consistency and penetration, which would be a serious defect when laying the pavement, as portions would be too hard and liable to crack, while other portions would become too soft under extreme warm weather. Of course this could be obivated by great care in the manufacture and by constantly testing the cement.

Prof. Richardson informed me that in some experiments he made he found it necessary to add residuum oil to the asphaltic cement when laying, in order to get it to a proper consistency. The Bermudez company state that they can produce the cement in large quantities to any required degree of consistency, and that the results will be much more uniform than with Trinidad. If this is the case, it will be a decided advantage in favor of the Bermudez asphalt, but until some pavements of Bermudez asphalt have been laid down and tested by time, it will be a doubtful question whether or not the volatile oils contained in this asphalt are not a defect and that they may cause the pavement to harden, crack and eventually disintergrate owing to their disappearance.

It was found that when Bermudez and Trinidad (refined) asphalts were immersed in water at 40 Fah., the Trinidad asphalt could be bent, while the other snapped. The most objectionable features of the Bermudez asphalt are that it softens rapidly under high temperatures and becomes brittle under low ones. If this can be overcome, and the asphaltic cement brought to a proper degree of penetration, I do not see why it should not make a first-class paving material, as chemically I cannot find anything to prevent it, with this exception, that a very slight increase in the temperature of the still when the refining process is going on would drive out all the lighter oils and the result would be the production of a pitch extremely brittle and having little cementitious value from which it would be impossible to make a paving mixture, as no admixture of artificial oils will restore this peculiarity to asphalt.

From enquiries which I made in reference to the supply, I find that Mr. Thomas, 25 Beaver Street, N.Y., tobacconist, is the firm that controls the importation, and that the refining works consist of four stills at South Amboy, which are not now in operation as there is no

crude Bermudez asphalt in the United States, and great difficulty has been experienced in obtaining it, the last two vessels on which the crude material was shipped having been lost, owing to the nature of the cargo, which is liable to shift in warm weather.

I understand there has only been about 900 tons of this material imported into the United States, of which a quantity was used in Detroit last year, where the Bermudez company laid 24,000 square yards of pavement, and the remainder is to be used in Washington, where this company has a contract to do about the same quantity of work. The information regarding the supply in Bermudez was very contradictory, and I was unable to obtain any definite information regarding it.

In conclusion, while I cannot see any reason to suppose that this asphalt should not make a good pavement, it must be remembered that we have not had a sufficiently long experience of its behavior under the varying influences of climate and street traffic and that although backed by such a high authority as Prof. De Smedt, it is practically an experiment which the promoters should be prepared to make at their own expense, and they should not expect the City to pay for it, or accept it, excepting with good and sufficient security in case it should prove a failure. In regard to its appearance as a pavement, Mr. C. H. Rust, I understand, has already reported to you after visiting the piece laid by the Bermudez company in Detroit.

I would suggest that, if possible, the work here should be laid under the personal supervision of Prof. De Smedt, who, I understand, is the chemist for the Bermudez Company, and whose reputation would be a guarantee that the work was carefully and well done.

I remain, etc.,

H. D. ELLIS,
Roadway Engineer.

Since writing this report I have had further time to make experiments with Bermudez asphalt and am desirous of modifying it in so far as the action of Bermudez at a low temperature is concerned. Some sticks of Bermudez and refined pitch lake asphalt were prepared about the size and shape of a small lead pencil. These were placed in water at a temperature of 32 degrees where they were kept

until they obtained the same temperature as the water. They were then broken across and were found equally brittle, the Bermudez asphalt, if anything, being the most tenacious. As, however, it must be taken into consideration that the amount of inorganic matter in the best refined pitch lake asphalt amounts to 36 per cent. of the whole, while in Bermudez asphalt it only amounts to 3 per cent., the probabilities are that if 30 per cent. of sand was added to the Bermudez, in order to bring the amount of bitumen in both asphalts on a par, that there would be very little to choose between the two asphalts on this point.

The following statistics taken from a paper read by Mr. Howard before the Rensellaer's Society of Civil Engineers, shows the popularity of this class of pavement on this continent:

The total quantity of asphalt pavement laid in America up to January, 1894, is approximately ..	13,900,000 sq. yds., or	911 miles.	
Asphaltic limestone pavements	151,000 "	10 "	
Asphaltic sandstone and other asphaltic materials, experimental and otherwise	619,000 "	41 "	
	14,670,000 "	962 "	
Total amount of asphalt laid in Europe up to the same date..... ...	2,223,413 sq. yds., or	151 miles.	

During the past year an investigation was also made into the relative adhesive quality of asphalts and their cements and for this purpose some tests were made, the following methods being employed: The two broken halves of a Portland cement briquette one inch square at the fractured part were joined together by dipping the broken portions in hot refined asphalt or hot asphaltic cement and then bringing the broken pieces together by pressure with the hands. The briquettes were then laid away for 24 hours in a room at which the temperature was 70 degrees Fah., they were then broken in the same manner that a Portland cement briquette would have been upon a Fairbank's cement-testing machine.

The following results are an average from several experiments and represent very fairly the adhesive power of the material. In every case the asphalt or asphaltic cement parted, excepting where

land asphalt was used. The land asphalt apparently had not sufficient cementing power to withstand the strain and parted from the ends of the briquette instead of being ruptured itself.

Refined asphalt (land)	73	lbs. per	sq. in.
Refined asphalt (lake)	315	"	"
Asphaltic cement (land asphalt)	211	"	"
Asphaltic cement (lake asphalt)	294	"	"
Best coal tar	90	"	"

From the above experiments it will be seen that the adhesive power of refined lake is greatly in excess of refined land, but that with the addition of the residuum oil this difference decreases to a considerable extent, but the lake asphalt even as an asphaltic cement has a great superiority over the land asphalt in this necessary quality for a paving mixture.

I propose to continue these experiments with some of the other asphalts now upon the market when I can obtain samples of them.

The guarantee of five years given by the Warren-Scharf Asphalt Company upon the pavements laid by them on Bay Street between King and Wellington, expired during the month of November. This was the first asphalt pavement laid in the City of Toronto and I understand was laid with Trinidad "pitch lake" asphalt. Excepting for some slight repairs, which will be made by the contractors as soon as the weather permits, it is in first-class order.

Now that the guarantee on many of the asphalt pavements is about to expire, it will be necessary to make some arrangement to keep these in order and I would recommend that a contract be entered into with one of the asphalt companies to do this work, as it will not pay the City to erect a plant for this purpose until the area of asphalt exempt from guarantee is considerably in excess of what it is at present.

CEDAR BLOCK PAVEMENTS.

Only a few of these pavements were laid during the past year, the depth of block being 6 inches on 6 inches of gravel, instead of a 7-inch block on 8 inches of gravel. This has had the effect of reducing the price of this class of pavement without affecting the quality of the work.

SPECIFICATIONS.

At the beginning of the year a complete revision of the roadway specifications and form of tender and contract were made, and several alterations in the manner of carrying out the work, in order to ensure better workmanship and avoid disputes regarding extras.

The bench mark work was continued during spare hours, but it is not progressing as rapidly as it should, owing to the press of other work.

I have the honor to remain,

Your obedient servant,

H. D. ELLIS,
Roadway Engineer.

CEDAR BLOCK PAVEMENTS ON SAND FOUNDATION

STREET.	From	To	Pavement	Kerb	Class of Kerb	Width	Length	Cost per Lin. Foot, Exclusive of Kerb.	Cost per Lin. Foot, Inclusive of Kerb	Cost per Square Yard	Completed	CONTRACTOR
			sq. yds.	lin. feet.		feet	feet	$ c	$ c	cts		
Royce	Symington	C. P. Ry	6,115	3,177	Wood	33	1,575	2 53	2 85	65	May 12, 1893	C. Farquhar
Perth	Bloor	Royce	9,041	6,628	"	24	3,143	1 84	2 14	64	July 15, 1893	"
Churchill	Terminus of pavement	130 feet east	330	330	"	18	146	1 67	1 97	80	May 9, 1893	J. J. Booth.
Shaw	College	Bloor	7,596	5,630	"	24	2,815	1 79	2 09	67	Aug. 5, 1893	R. Grant.
Northumberland	Osington	Preston	611	524	"	24	262	1 64	1 94	70	Aug. 3, 1893	Shannon, Whillans & Co.
Olive	Bathurst	Palmerston	1,714	1,552	"	24	596	1 86	2 16	67	Aug. 14, 1893	" "
Huron	Pheobe	Grange	1,742	1,554	"	24	692	2 20	2 60	79	Aug. 29, 1893	R. Grant
Euclid Place	Euclid Ave.	East terminus	160	320	"	9	160	1 25	1 25	84	Aug. 22, 1893	Constructing and Paving Co.
Mansfield	Manning	Clinton	841	612	"	24	293	1 78	2 02	61	Sept. 8, 1893	Clark & Connolly
"	Bellwoods	Grace	621	466	"	24	233	1 83	2 13	60	Sept. 28, 1893	E. M. Cathro.
Bleeker	Wellesley	Howard	3,636	3,091	"	21	1,550					Day labor by Street Commissioner.

CEDAR BLOCK PAVEMENT ON CONCRETE FOUNDATION, WITH GRANITE TOOTHING.

Howard Park Ave	Dundas*	Roncesvalles	1,310			16½	842	3 66	$1.50 cedar 3 80 granite	May 12, 1893	C. Farquhar
Gerrard	River	Pape	7,722			16½	4,910	3 62	1 46 cedar 3 70 granite	June 15, 1893	Clark & Connolly
"	Parliament	River	3,246			16½	2,102	3 52	1 60 cedar 3 80 granite	Sept. 15, 1893	Shannon, Whillans & Co.
Bathurst	King	Queen	1,827			16½	1,175	3 19	1 10 cedar 3 40 granite	Oct. 7, 1893	"
Broadview	Queen	Gerrard	3,904			16½	2,509	2 73	1 10 cedar 1 30 granite	Nov. 4, 1893	Burns & McCormack.

CEDAR BLOCK PAVEMENT WITH SAND FOUNDATION ON SIDE, AND CONCRETE IN TRACK ALLOWANCE, WITH GRANITE TOOTHING.

Dundas	Sorauren	Bloor	13,250	5,646		42	2,796	6 10	$1.50 cedar on concrete 70 " sand. 3.80 granite	July 8, 1893	C. Farquhar
High Park Ave	Roncesvalles	High Park	10,269	4,578		40	2,269	5 23	1 10 cedar on concrete 60 " sand. 3.00 granite	June 29, 1893	

CEDAR BLOCK PAVEMENT ON PLANK FOUNDATION AND TAR COMPOSITION

Victoria Cres	Dunn	Jameson	2,023	1,533	Wood	24	751	3 07	3 37	$1 11	Sept. 2, 1893	Shannon, Whillans & Co.

ASPHALT PAVEMENTS

Richmond	Victoria	Bay	3,976	2006	6 in. stone in concrete	12	852	10 72	12 72	$2 10	June 27, 1893	Constructing and Paving Co.
Earl	Sherbourne	Western terminus	1,472	1,332	4 in. stone in sand	20	634	5 01	6 31	1 80	July 13, 1893	Trinidad Asphalt Co.
Winchester	Parliament	Sumach	5,816	3,068	" "	34	1,542	10 71	12 11	$1.95 4-inch. 3 00 10 inch	Aug. 24, 1893	Constructing and Paving Co.
Munn's Lane	Wellington	218 feet north	464	154	" "	18	218	3 82	5 22	$1 88	Aug. 25, 1893	Trinidad Asphalt Co.
Dundas	Queen	Arthur	3,013			16½	1,937	5 12		2.92 asphalt 4.00 scoria	Sept. 11, 1893	Constructing and Paving Co.
Gerrard	Yonge	North	1,535	1,374	4 in. stone in sand	20	667	5 32	6 72	$1 96	Sept. 25, 1893	Trinidad Asphalt Co.
College	"	McCaul	4,417			16½	2,806	5 75		3.30 asphalt 4.25 scoria	Sept. 28, 1893	" "
Carlton	"	Parliament	6,202			16½	4,072	5 42		2.95 asphalt 4.00 scoria	Sept. 28, 1893	Constructing and Paving Co.
Parliament	Queen	Gerrard	3,742			16½	2,490	6 10		3.50 asphalt 4.50 scoria	Sept. 27, 1893	Warren Scharf Co.
"	Winchester	Carlton	725			16½	466	5 97		3.40 asphalt 4.50 scoria	Sept. 22, 1893	"
Queen	Yonge	River	10,160			16½	6,215	5 60		3.02 asphalt 4.00 scoria	Oct. 13, 1893	Constructing and Paving Co.
Parliament	Gerrard	Carlton	1,370			16½	880	6 34		3.40 asphalt 4.50 scoria	Sept 23, 1893	Warren Scharf Co.
College	McCaul	Bathurst	6,201			16½	3,933	5 97		3.35 asphalt 4.50 scoria	Oct. 4, 1893	Constructing and Paving Co.
Lane round Inland Revenue Office			290	210	4 in. stone in sand	8 to 12	265	3 01	3 76	$2 60	Oct. 5, 1893	Trinidad Asphalt Co.
York	Front	Queen	3,190			16½	2,066	5 75		3.30 asphalt 4.25 scoria	Oct. 18, 1893	" "
Linden	Sherbourne	Huntley	1,429	1,191	4 in. stone in sand	22	585	7 06	8 55	$2 62	Oct. 21, 1893	Constructing and Paving Co.

VITRIFIED BRICK PAVEMENTS.

College	Dufferin	Lansdowne	3,203			16½	2,059	4 34		$2 58	Sept 13, 1893	Clark & Connolly
Lansdowne	College	Dundas	692			16½	440	4 72		2 90	Sept 13, 1893	" "
Dundas	Arthur	Jameson	7,487			16½	4,951	4 13		2 45	Oct. 12, 1893	Shannon, Whillans & Co.
College	Concord	Dufferin	3,779			16½	2,377	4 20		2 35	Nov. 27, 1893	D. L. VanVlack
"	Bathurst	Clinton	2,633			16½	1,693	4 24		2 39	Nov. 8, 1893	"
Bathurst	Queen	Harbord	8,333			16½	5,357	4 36		2 48		J. B. McKnight
College	Clinton	Concord	4,170			16½	2,680	3 94		2 21	Nov. 7, 1893	Shannon, Whillans & Co.

STONE SETT PAVEMENTS.

Front	Frederick	Church	2,488			16½	1,594				Oct. 21, 1893	A. J. Brown
Church	Front	Queen	2,437			16½	1,567				Nov. 8, 1893	Robert Grant
Front	Simcoe	Church	5,042			16½	3,215				Nov. 15, 1893	"
Yonge	Front	King	1,232			16½	792				Oct 27, 1893	"
Church	Queen	Bloor	10,554			16½	6,656				....	E. M. Cathro.
Bloor	Yonge	Spadina	7,564			16½	4,668				Dec. 12, 1893	Chas. Farquhar
Frederick	Front	King	426			16½	300					Day labor
Sherbourne*	"	"	426			16½	274					"
George	"	"	426			16½	300					"
Front*	Frederick	Sherbourne	720			16½	393					"

* Only the concrete foundation laid in 1893.

CONCRETE SIDEWALKS

STREET.	From	To	Side	Length.	Width.	Cost per Lineal Foot	Completed	CONTRACTOR.
				ft. in	ft. in.	$ c		
Sherbourne	Gerrard	Wellesley	East	2,146 0	6 0	1 19	Aug. 8, 1893	A. Gardner & Co.
"	Wilton	Bloor	West	4,731 5	6 0	1 12	Oct. 2, 1893	"
Queen St. College Ave	Queen	College	"	3,342 0	8 0	1 57	Oct. 9, 1893	R. Forsyth & Co.
Front	At R. & T. Watson's		South	62 0	16 9			Private
"	Simcoe	Easterly	North	163 11	9 8 and 12			"
Sherbourne	No. 559	No. 563	East	119 7	6 0			"
Gould	At O'Keefe's Brewery		South	113 8	11 and 11 6			
Front	At Toronto Biscuit Co.'s		"	49 2	12 6			
Munn's Lane	Wellington	Northerly	West	142 5	5 0			"
King & Jarvis, south-east corner				122 9	12 0			
Adelaide	Opposite Nos. 60, 60½ and 62		North	41 4	10 6			
Sherbourne	" " 265, 267 and 269		East	82 5	7 4			
"	" " 275 and 279		"	40 5	7 5			"
Colborne	Nordheimer's		North	50 10	7 6			"
Duke	Christie, Brown Biscuit Co.		South	50 0	9 5			"
Wellington	Munn's Lane	Westerly	North	81 0	11 0			
Exhibition Park	In front of Grand Stand			555 0	18 0			

STONE FLAG SIDEWALK.

Front	Church	Westerly	North	184 0	12 0		Private

STEEL BRIDGE CONNECTING CITY CATTLE MARKETS.

BRIDGE ENGINEER'S REPORT.

TORONTO, December 31st, 1893.

E. H. KEATING, ESQ.,
City Engineer:

CATTLE MARKET BRIDGE.

In January of this year the masonry piers were built and ready to receive bridge. Designs had been made and contract awarded to the G. & I. Brown Manufacturing Co., of Belleville, but on account of the agreement for some portion of the land, between the Grand Trunk Railway Co. and the City, not being signed, work on the superstructure was not commenced until the beginning of May. Meanwhile carpenters were at work erecting the ramps, three in number, one on the north side, leading into the old Cattle Market, 150 feet long; one on the south side, leading from bridge to new Cattle Market, also 150 feet long, and the other leading from bridge to Grank Trunk sidings on the south-east; this ramp is 250 feet long. Each of the ramps is 20 feet wide, with fenced footway 4 feet wide.

Men commenced erecting the steel superstructure on the 22nd July. The bridge was finished and tested in the presence of Ald. Crawford, the Chairman of the Markets and Licenses Committee, and myself, on Thursday, September 14th, 1893, everything being found good and satisfactory.

QUEEN STREET BRIDGE OVER RIVER DON.

On January 30th, 1893, a contract was entered into with the Hamilton Bridge Co. to strengthen this bridge. Plans were prepared and submitted to the Committee and work commenced. This strengthening was accomplished by virtually adding a bow string bridge complete in every respect, with a new set of floor girders to the present bridge. So that instead of being a very weak bridge, it is now equal to the heaviest City traffic. This work was finished in April, and the roadway raised and graded to suit the deck of strengthened bridge.

EASTERN AVENUE BRIDGE.

This bridge has had a new deck on roadway portion and sundry repairs.

Yours respectfully,

JOHN WILLIAMS,
Assistant Engineer.

SURVEYOR'S REPORT.

SURVEY DEPARTMENT,
Toronto, Dec. 31st, 1893.

E. H. KEATING, ESQ.,
City Engineer:

DEAR SIR,—I beg to submit the following report on the business of this Department during the past year. In addition to the regular routine business of the office, which has been of similar character to that of previous years, and therefore need not be more particularly enlarged upon, the following are some of the more important matters which have been under my supervision: Esplanade Agreement, Windmill Line Extension, Dundas Street Bridge Claims, Don Improvement, Lake Shore Road Arbitration; Hanlan, Heber and Morris Arbitrations (Island), and the preparation of the City Plan. In addition to the above, plans were prepared of the following City properties: Market Block, Walks and Gardens Property, Water Front and the Island.

ESPLANADE AGREEMENT.

Mr. Ex-Alderman Defoe having been appointed by the Council to assist me in dealing with the real estate claims, the first matters dealt with were the settlement of the claims of the MacMurray, Fuller Estate, Dissette (Cosby Hall), F. A. Noverre, also the Toronto Canoe Club, Forman, Bassett, McMurchy, and the Toronto Rowing Club. The interests of the latter five having also been acquired by the C.P.R., the settlement was rendered more complicated. After considerable negotiation with the several parties and their solicitors, the above claims were adjusted, and, having been reported to Council, authority was obtained for the following settlements:

MACMURRAY, FULLER ESTATE.—630 feet on south side Esplanade, between York and Simcoe Streets; average depth, 450 feet. Entire interest bought out for $13,500.

DISSETTE (Cosby Hall Hotel and Lot).—Lot, 60 feet frontage, being part of MacMurray, Fuller Estate. Entire interest bought out

for $11,000. The settlement included value of hotel, cribbing, filling, piling, etc.

F. A. Noverre.—Frontage of 50 feet, part of MacMurray, Fuller Estate, boat-houses and boat-building business. This settlement was effected by an agreement to move the boat-houses on to a new lot of 60 feet frontage south of Lake Street, which has now been completed.

C.P.R.—Forman, frontage 25 feet; Bassett, 25 feet; McMurchy, 25 feet; Toronto Canoe Club 25 feet; and the Toronto Rowing Club, 75 feet. It was necessary to deal with the C.P.R. in this matter, the sum of $18,000 being paid for their entire interest. With the other sub-tenants of the above estate the C.P.R. had made agreements which by the Esplanade Agreement the City undertook to carry out. These were the Argonaut Rowing Club, Messrs. Elgie and Stewart, and the Royal Canadian Yacht Club. These agreements having been made prior to the negotiation and settlement of the Esplanade Agreement, it was found practically impossible to carry them out, owing to the altered circumstances, and new agreements were therefore negotiated with these parties, with the following result:

Argonaut Rowing Club.—Frontage of 50 feet, south side Esplanade, along west side of York Street. A new wharf was constructed, and the club-house moved by the City on to a new lot on the south side of Lake Street, immediately west of York Street, while a payment of $750 in cash was made in consideration of the Club waiving certain conditions in the old agreement.

Messrs. Elgie & Stewart.—Frontage 125 feet, south side Esplanade. The difficulty in this case was increased through the burning of the buildings shortly prior to the time of moving. This settlement was effected as follows: new cribs and wharf were constructed on a lot south of Lake Street, near the foot of the west ramp of the York Street bridge, and the unburnt boat house was moved. In addition a cash payment of $5,000 was made, and the Cosby Hall Hotel, the Canoe Club, and some other boat-houses acquired by the City, were given to Mr. Elgie, who moved them on to the new wharf himself.

Royal Canadian Yacht Club.—Frontage 60 feet, south side Esplanade. The following settlement was arrived at in this case. In order not to interfere with the business of the Club they were per-

mitted to have the use of their own club-house during the season. A new wharf was built next west of Noverre's, on a lot having a frontage of 85 feet, and on to this the building acquired from the Toronto Rowing Club was moved by the City. A cash payment of $2,300 was made in consideration of all other claims and conditions arising under the old agreement. The moving being completed, the Club handed over to the City its own building, and have now enlarged and greatly improved their new premises.

The result of this final settlement with the MacMurray, Fuller Estate and sub-tenants, has been one of great benefit with regard to the appearance of the water front in this locality. We have now on this property three handsome and commodious club-houses, being the Argonaut Rowing Club, Toronto Canoe Club and Royal Canadian Yacht Club, in addition to the compact and suitable public boat-houses and boat-building establishments on the properties of the Argonaut, Elgie and Noverre. These properties are held under renewable leases from the City, the rents being settled at periods of 21 years. The total annual rent for the first period amounts to $1,690.

As provided in the Esplanade Agreement, parts of Esplanade Street, Simcoe Street, John Street and Peter Street were closed by By-law and conveyed to the G.T.R., which corporation, having acquired the necessary land on Front Street for the new portion of the Union Station, was then enabled to commence operations. The south train-shed is now finished, and work on the new station is well advanced. The only matter of any importance in connection with this Agreement yet to be carried out is the handing over of the Alternative Site by the City to the C.P.R., but owing to certain differences of opinion as to the interpretation of the Agreement with regard to this, the transfer has not yet been made. It is to be hoped, however, that before long an amicable solution of the difficulty may be arrived at without recourse to a law suit.

WINDMILL LINE AGREEMENT.

In connection with the Windmill Line Agreement the clerical work is now all complete, as the Order-in-Council authorizing the proposed extension of last year issued in July, and the patents to the City have now been issued under its authority. This involved a large

amount of work, as the necessary surveys, as well as all the descriptions and plans, were prepared in this office, in addition to which I had to visit Ottawa and Montreal on several occasions, in order to arrange the details with the Departments in Ottawa and the C.P.R. in Montreal. Under the provisions of the Agreement and these patents the southerly limit of the water lots, now known as the new Windmill Line, has been extended a distance southward of 644 feet, between Princess and York Streets, running back to the old Windmill Line at Parliament and Brock Streets, to the east and west respectively. By this final extension all the City wharves can be built into deep water, and the wharves themselves made of a practical length which was not the case under the first proposal, the then extension leaving only about 300 feet for wharf purposes south of Lake Street when constructed. For the construction of the latter street, which runs from John Street to Parliament, a limit of 15 years is defined, and, for the filling of the prolongations of the present streets running southward, a limit of 10 years.

DUNDAS STREET BRIDGE CLAIMS.

These claims were referred to me for settlement, and after many interviews and much negotiation the following were settled, namely, those of Lennox, Waterhouse, Brodie, McGregor, Murray and Crocker, at a total cost of about $9,000. With the remaining claimants, namely, Mrs. Mallon, John Mallon, St. Helen's Church, Mallon & Woods, Daly, Foley and Hunter, it was found impossible to settle, and their claims are therefore now being adjusted by arbitration.

DON IMPROVEMENT.

A complete survey has been made and a plan prepared showing the lands taken and all the buildings adjacent thereto. Without this plan it would be impossible to complete the necessary assessments and make the settlements with the railroad companies using this improvement. A large amount of information was also collected concerning the cost of the lands expropriated and of the work as carried out. Everything is now in such a condition that the clerical work may be proceeded with at any time.

OFFICIAL LIST OF CITY STREET NAMES.

The preparation of a list of the City streets having been referred to me, I found on investigation that under the provisions of the Muni-

cipal Act the City is bound to keep an official list of all streets in the municipality. This having never been prepared, I proceeded to have one compiled, which, besides the examination of directories, old maps and registered plans, necessitated the searching of all By-laws and resolutions of Council passed at any time for the naming or re-naming of streets in the City. This list when complete brought to light a large number of duplications and ambiguities, which it has been thought advisable to amend before the final confirmation of the list by the County Judge. The matter has been relegated to a sub-committee of the Board of Works to be dealt with.

Finally, much information was supplied to the City Solicitor, Assessment Commissioner, City Commissioner and City Treasurer relating to the measurements and areas of various City properties, and other data of similar character.

Respectfully submitted.

VILLIERS SANKEY,
City Surveyor.

STREET COMMISSIONER'S REPORT.

STREET COMMISSIONER'S OFFICE,
Toronto, December 31st, 1893.

E. H. KEATING, ESQ.,
City Engineer:

CEDAR BLOCK ROADWAYS.

DEAR SIR,—In my report of last year I tabulated a number of streets on which the pavements were entirely worn out. With the exception of Winchester Street, from Ontario to Parliament Street, the owners of property abutting on those streets have not taken any action with a view to having new pavements laid. It is needless to say that the roadways have not improved during the year that has elapsed.

As per your order of March 28th, 1893, I have made no repairs to any of the pavements on the streets mentioned therein, namely:

STREET.	From	To
Nassau	Lippincott	Spadina.
Bellevue	College	Bellevue Place.
Lisgar	Queen	Dundas.
Henry	Baldwin	Ceeil.
Sullivan	Beverley	Spadina.
Ceeil	"	"
D'Arcy	"	"
Baldwin	"	"
Orde	McCaul	East end.
Prospect	Rose	Parliament.

In view of the imminent danger of accident by reason of these worn-out pavements, I think it would be prudent to remove the blocks entirely from the worst ones and lower the culverts. This would protect the City from actions for damages, and in addition would in a measure have the effect of compelling the property owners to interest themselves in getting new pavements laid.

I might point out that the blocks are not so much worn with traffic as they are rotted away. Of course the process of destruction

is accelerated by reason of the constant disturbance they are subjected to in the putting in of water and gas services, drains, conduits, etc

A number of these pavements were inspected by the Deputy City Engineer and myself in 1891, but our report, forwarded to the Works Committee, did not reach Council.

I would instance the following, as requiring immediate renewal:

Street.	From	To	Year. Constructed.
Prospect	Rose	Parliament	1882
D'Arcy	Beverley	McCaul	1881
St. Patrick	Spadina	McCaul	1881–82
Cecil	Beverley	Spadina	1882
Amelia	Sumach	Parliament	1884
Baldwin	Beverly	Spadina	1882
Bellevue	College	Bellevue Place	1882
Northcote	Queen	Afton	1883
Nassau	Spadina	Bathurst	1881–82

A considerable amount of repairing has been done to roadways of this kind. As the end of their lifetime approaches, the repairs, of course, become much heavier.

The total amount expended under this head was $14,603.98.

MACADAM, COBBLE, AND STONE SETT.

The macadam roadways, speaking generally, have never been in such a good state of repair as during this year. As you are aware, where the traffic is mixed, as is the case in this city, roadways of this character require constant attention.

One difficulty we have to contend against, as pointed out in my last report, is that these roads were improperly constructed in the first place. In many instances the stone was simply dumped and levelled over the street, the channels receiving no attention.

Considerable lake gravel has been used, principally on streets in the residential section of the City. This material is much cheaper than stone and gives a better surface.

At a meeting of the Board of Works on August 4th, 1893, (Report No. 25, adopted in Council, August 14th, 1893) it was ordered that from the commencement of the new year no repairs, etc., should

be made to macadam roads, except as a local improvement; all work thereon to be of a permanent character. This regulation was advertised in the newspapers in September last.

The following are statements of macadam, stone and lake gravel delivered to the City during the year. In the former you will notice that the large amount of 178.40 toise was collected by the District foremen. Averaging this at $9.50 per toise, it represents a direct saving to the City of nearly $600.

STATEMENT OF STONE RECEIVED FOR MACADAM DURING 1893.

Contractor.	Locality Delivered.	Toise.	Cost per Toise.	Total cost, including cost for breaking.
			$ c.	$ c.
J. McKim	Shaftesbury Ave	27.13	11 00	394 56
J. McKim	Breadalbane St	26.03	9 50	392 03
S. Cook	Shaftesbury Ave	7.38	16 00	118 08
P. Wilson	Portland Yard	156.40	10 90	2,705 33
Burns & McCormack	Nassau St	7.18	9 00	107 70
J. Goldring	Frederick Yard	18.22	8 40	271 56
"	Princess St.	9.10	8 40	140 14
"	Sherbourne St.	75.41	8 40	1,110 90
R. Goldring	Mill St.	19 42	9 90	319 25
E. Goldring	"	19.68	9 90	323 47
M. O'Brien	Sherbourne St.	6.19	8 40	54 50
J. Hilts	Frederick Yard.	10 31	8 40	163 46
A. W. Godson	Charlotte St.	8 20	15 00	123 00
P. Wilson	Givens St.	13.34	15 00	200 10
F. McKeown	Princess St.	3.14	15 00	47 10
Gathered by Corporation	Foremen	178.40	.....	1,095 52
Old cobble taken from	tracks	48 20	.....	324 83
		633.73		7,891 53

Macadam and Stone on Hand.

Macadam and Stone.	Toise.	Value per Toise.	Total value
		$ c.	$ c.
Macadam	202.53	16 00	3240 48
Unbroken stone	5.00	10 90	54 50
Old Cobble	800.00		.....
New Cobble	101.00	.....	.....

STATEMENT OF LAKE GRAVEL RECEIVED IN 1893.

Contractor.	Locality.	Cost per Cubic yd.	Cubic Yards.	
		c.		$ c.
James Hilts	Frederick Yard	75	1,310.0	982 50
R. Goldring	"	75	1,103.7	827 78
"	Polson's Dock	75	139.5	104 63
"	Dufferin Wharf	75	147.5	110 63
T. Lundy	Frederick Yard	75	31.3	23 48
M. O'Brien	"	75	762.1	571 58
"	Dufferin Wharf	75	102.4	76 80
S. Webster	Frederick Yard	65	76.4	49 66
E. Goldring	"	75	70.2	52 65
"	Polson's Dock	75	151.7	113 78
"	Dufferin Wharf	75	154.2	115 65
Joseph Adamson	Frederick Yard	75	35.0	26 25
S. Marchment	Don Flats	75	294.1	220 58
J. Goldring	Frederick Yard	75	82.4	61 80
"	Dufferin Wharf	75	93.3	69 98
			4,553.8	3,407 75

Quantity of gravel on hand 370.8 cubic yards.

The cobble repairs have been largely on channels and cobble paved lanes.

Regarding stone sett roadways, I beg to point out that Yonge Street, south from King Street, and Wellington Street, from Yonge to Bay Street, particularly the latter, will require considerable repairing during the coming year. Their present condition proves conclusively that pavements of this character should in all cases be laid on concrete.

We have on hand at present 901 toise of cobble stone, most of which has been taken from streets where new pavements have been laid. During the coming winter I think it would be well for the Council to appropriate a sum of money for the breaking of this stone, with a view of providing employment for the deserving poor.

RECONSTRUCTION.

Under this head I would draw attention to the paving which has been done by order of the Committee on Works between the tracks and the kerb on Gerrard Street, from River Street to the Don River, and charged to our Reconstruction Account.

A great deal of work has been done this year in connection with the change of the street railway system. The total mileage of roadway reconstructing done was 14 miles double track. I may mention that in conjunction with the paving up to the rails toothing was laid on the outside, the cost being charged to the several track allowances.

TORONTO RAILWAY PAVEMENTS.

Stone setts on concrete foundation were laid on George and Frederick Streets, from King to Front Street, at a cost of $3.67 per square yard. This includes the setts and the work of dressing same from 7 to a depth of 5 inches, to correspond with the new rail. The redressing was done largely in the winter season, with the object of finding employment for a large number of mechanics. There can be no doubt but that the cost was somewhat enhanced thereby for the reason that all the men were not strictly first-class.

The face of the setts are about 4 x 5 to 7 inches, these being in my opinion preferable to setts of larger dimensions.

The pavements are first-class in every respect, and will, I am sure, compare favorably with any others of the same nature wherever laid.

I may add that the greater portion of the setts used in this work were purchased by contract in 1888 and 1889. A number, however, were taken from other streets.

Other portions of streets, together with track allowance on which stone setts were laid, are the intersections of Frederick, George, Church and Front Streets, and Front from Church to Frederick Street. The concreting was done by contractor A. J. Brown. The cost of this work was $2.60 per square yard.

The concreting on Sherbourne, from King to Front Street, was done by this Department. The macadam that was formerly in the track allowance has been restored temporarily. The work will be properly completed next year.

SCAVENGERING.

The total expenditure on this service was $58,324.23. The most important matter I have to report under this head is the experiment that was made of handling the ashes and garbage by electric motive power during the two closing months of the year. A ramp was constructed on Armour Street, near the King Street Subway, to

which the Toronto Railway Co. laid a siding from the main line. Six cars were built (the trucks being supplied by the Railway Co.), having a capacity of 13 cubic yards each. These were loaded from the scavenger carts at the ramp mentioned above, and hauled, after traffic had ceased, by electric motor over the King and Queen Street tracks to Booth Avenue. From this point a temporary track was laid to the water front, over which the cars were hauled by horse power and the contents dumped. I regret to say that the Council did not see fit to adopt permanently this method of handling the City's refuse. The following is from the report I submitted on the matter, setting forth the details:

The cost of removing garbage as at present handled from No. 9 District (west of O'Hara Ave.) to York St. dump, on the basis of 30 cart loads (3 car loads) is	$20 75
To move same quantity by electric power to Ashbridge's Bay (Booth Ave.) would cost	21 15
A difference in favor of York St. dump of	40
To haul the same quantity by carts to the Booth Ave. dump will cost	36 75
A difference in favor of electric system of	9 60
To haul same quantity by electric system from a given point in the neighborhood of Beatrice and College Sts. to Booth Ave. would cost	16 15
A difference in favor of electric system (over York St.) of	4 60
Cost of hauling by carts from same point to Booth Avenue would be	30 75
A difference in favor of electric system of	14 60
Operating from the City lot at Tannery Hollow on Yonge St., a comparison of the cost of hauling by cart to York St. and by electric system to Booth Ave., shows a difference in favor of the latter of	2 65
A comparison of the cost of hauling by cart to Booth Ave. from the same point shows a saving in favor of electric system of	7 60

The plant required to operate the electric system, based on the figures supplied by the Toronto Railway Company for the car trucks, etc., would be in the neighborhood of $5,000; this amount, of course, includes the two additional ramps, namely at College St. and Tannery Hollow.

The calculations submitted above are based on the scavengering work as it is at this season of the year, when there is an additional quantity of ashes to be removed. The material handled in the summer would probably be one-third less, and is garbage principally.

My chief reason for advocating the adoption of the above scheme was owing to the fact that our means of disposing of refuse are becoming every year more and more restricted. Early in the spring we were compelled to discontinue using the High Park dump, and, later, the dump on Arthur St. This, of course, necessitated a much longer haul, and a corresponding increase in the cost of the service.

Pursuant to an agreement made between the City and the Canadian Pacific Railway Company in the early part of the year, we have been dumping all the ashes and other suitable material collected in the section bounded by College, Spadina and Sherbourne Sts., at the water-front, including Lake St. A very large area has been reclaimed.

Owing to the large increase in the collection in the West End, I found it necessary to add another sub-section in the Spring.

The total number of loads collected throughout the City during the year was 80,106; of these 9,662 were consumed at the eastern crematory

The new crematory erected this year for the western section of the city will be of very great advantage in connection with the service. Since operations were commenced on Oct. 6th, the number of loads consumed was 1,424.

STREET WATERING.

Owing to the large amount of reconstruction work and paving of track allowances, etc., in operation during the summer, the service was somewhat handicapped. On the whole, however, we have had very few complaints In accordance with your instructions we are confining the watering on Yonge and King Streets where asphalt is laid, to the track allowance. If some arrangement could be made with the Toronto Railway Company, whereby they would undertake to water the area occupied by their rails, I think it would be of very great advantage to everybody concerned. At present there is considerable risk to the horses, especially on the streets mentioned above, even with the most careful driving, by reason of the speed of the trolley cars. Also, the necessity there is of constantly turning the wagons on and off the tracks causes considerable delay.

Since my last annual report I have fitted the greater number of our watering carts with side-valve sprinklers. These are worked by

a lever attached to the driver's seat, by which he is enabled to throw light or heavy spray on either or both sides as may be desired. Not the least of the advantages these sprinklers have over the old-fashioned semi-circular pipe sprinkler is the great saving effected in the quantity of water consumed. With the latter it was impossible to satisfactorily water streets that are paved with asphalt or brick in the centre, and cedar on the sides, as the first-named pavements require about one-third only of the water necessary to properly sprinkle the wood during the hot season.

The total quantity of water used in the service was 5,922,500 gallons: representing 135,930 loads.

The following is a memo. of the number of horses, wagons, carts, etc., in the possession of the City at present, being connected with this Department and used in the scavengering and street watering services:

WESTERN STABLES.

Horses	49
Water wagons	25
" carts	2
Scavengering carts	40
Setts of team harness	23
" single "	43

EASTERN STABLES.

Horses	54
Water wagons	22
" carts	4
Scavengering carts	45
Setts of team harness	19
" single "	55

I desire to add that our horses with few exceptions are thoroughly sound and in the best of condition. They certainly reflect great credit on the men who have charge of them.

I have no hesitation in saying that the city pays less for veterinary fees than any corporation in the country owning the same number of horses.

It is necessary that I should again draw attention to the extremely dilapidated state of the frame structures which do duty as stables in the western section of the city. It is absolutely certain that new stables will have to be erected, or extensive repairs made to

the existing buildings in the near future. As a result of the many representations I have made in regard to this matter, a sub-committee was appointed in the early part of the year to examine the whole subject of our yard accomodation in the West End. In the course of their investigation they visited our stables, and were unanimously of the opinion that new stables should be erected without delay. As a result of their labors a portion of the the property owned by the City, (extending from Dufferin Street easterly) on the north side of King Street, was placed at our disposal for the joint purpose of yard and stable accommodation. In my estimates for the coming year, I have placed an item of $5,000 for new stables.

POUND FEES.

The fees from the City pounds were as follows:

Northern pound.	$168 70
Eastern "	116 25
Western "	17 00

WOODEN SIDEWALKS.

The total mileage constructed was 19.672 miles; material used was 969,243 feet of lumber and 21,721 lbs of nails. The work of repairing has received every attention, and the walks throughout the City are in fair order. (For details of wooden sidewalks constructed as local improvements, see Appendix "A," pages 21 to 24.)

The sum of $1,020 70 was paid to the City Treasurer by property owners for extensions of sidewalks constructed opposite their premises.

Monies received and handed to Treasurer on miscellaneous accounts totalled $278.71.

STONE AND WOODEN CROSSINGS.

Considerable repairing has been done this year. A number of new crossings have been constructed and others altered to suit the new grades to which the permanent pavements have been laid. The square tamarac crossings continue to give every satisfaction.

STREET OPENING PERMITS.

These to the number of thirty-three have been issued to builders and others. The amount left on deposit as a guarantee that the

walks would be properly restored was $365, of which $335 has been refunded.

SNOW CLEANING.

The mileage of sidewalks from which snow was cleaned by this Department, as provided by By-laws Nos. 2464 and 2952, during the winter of 1892-93, was 299 miles, or 1,574,340 lineal feet, at a cost of $7,737.92, being at the rate of one-half cent per lineal foot each cleaning. This, of course, is charged as a local improvement against the property where the cleaning was done.

Out of a total of over 44,000 entries there were not more than 200 complaints or inquiries in regard to the charges for this service. I submit that this speaks well for the way in which the measurements were returned and the compiling of the reports in the office.

We have just completed a set of books for use in this work during the coming winter, whereby we shall be able to deal with inquiries much more expeditiously than in the past.

KERB REPAIRS.

This work has been confined chiefly to repairs. Considerable alteration and repairing has been occasioned by the construction of permanent pavements and changes of grade.

CULVERTS AND GULLIES.

The culverts and gullies, numbering some 7,000, receive regular attention. Each one is cleaned on an average nine times during the year.

STREET CLEANING.

Since May last the asphalt pavements have been cleaned by the patrol or orderly system. While a little more expensive, it is the most satisfactory way of cleaning this class of pavement during the summer season, as a very small quantity of dirt and debris mars the appearance of the street; and as the asphalt, with the exception of the track allowance on King, Queen and Yonge Streets, is not watered, it is highly necessary that all streets paved with this substance should be kept as clean as possible.

The cleaning of the other streets has received regular attention, special efforts having been made as exigencies required. The number of miles cleaned during the year was 1,302; the loads of sweepings

totalled 155,988. The amount expended on the service was $70,148.72. I may point out that the cost of removing snow from street intersections on the main thoroughfares, bridges, crossings, sidewalk wings, etc., is all charged against this appropriation.

CITY YARDS.

Our most important yard is the eastern or Frederick Street yard, on the Esplanade. This is a veritable hive of industry. All the carts, wagons, sweepers, etc., are constructed here, also repairs to same, together with a large portion of the horseshoeing. A large quantity of lumber and posts is delivered at this yard, and sawn into proper lengths by steam power. A considerable amount of work is done for the Sewer and other Departments.

During the summer the large Optimates power hammer that was formerly used at the Central Prison, was placed at this yard by the agent, Mr. R. E. H. Buckner, on trial. We have been using it on various classes of work, and on some special lines, such for instance as working up old iron for the manufacture of horseshoes, manhole steps, etc., we find it of very great service.

Owing to the inadequate accommodation of the yard on east side of Bathurst Street, immediately north from College Street, occupied by us for some years past as a storage yard, etc., we have been allotted, as before mentioned, a portion of the city property extending easterly from Dufferin Street on the north side of King Street. Previous to this arrangement being consummated, the sub-committee having charge of the matter advertised for suitable sites for our use, but no satisfactory offer being received, it was ultimately decided to utilize City property. Arrangements were subsequently made with the Parks and Gardens Committee whereby the cottage which stood on the ground east of the yard was taken over by us as an office, and the sheds and stable have been turned into storage rooms for tools, nails, etc. Since the property came into our possession we have had it properly drained and graded, the entrances planked and the front sodded. A neat fence has been erected the entire length of the frontage, the whole giving a clean and tasty appearance. Great advantage is derived from the switches connecting with the Grand Trunk and Canadian Pacific Railways, by which lumber and other material is shipped by the respective contractors direct to the yard. By reason of this facility they are enabled to tender for the City's

supplies at a lower figure, as no provision has to be made for cartage charges. If the City's stables were located on this site the advantage just mentioned would be enhanced proportionately in the direct delivery of all our feed supplies, etc. I trust, therefore, that the members of the City Council will see the advisability of setting apart an additional portion of the vacant land to the west of this yard, and appropriating the necessary funds, in the near future, for the purpose of providing suitable accommodation for the large number of valuable horses owned by the City.

Respectfully submitted.

JOHN JONES,

Street Commissioner.

APPENDIX "A."

ACCOUNTANT'S STATEMENT.

CITY ENGINEER'S OFFICE,
December 31st, 1893.

E. H. KEATING, ESQ.,
City Engineer.

DEAR SIR,—

I attach statement showing the expenditure for the year ending December 31st, 1893.

Yours truly,

WM. McCARTNEY,
Accountant.

For Abstract of Charges see Page	ACCOUNTS.	$ c.	$ c.	$ c.
	GENERAL WORKS.			
4	Bridges, repairs and maintenance....	1,627 23		
4	Engineering and expenses	25,922 15		
4	Kerbs, stone and wooden.	2,899 64		
5	General purpose	38,928 89		
6	Private drains.	797 84		
6	Roadways.	48,047 64		
7	Reconstruction of cedar block pavements	30,028 99		
8	Sidewalks.....	22,649 00		
8	Street cleaning	70,148 72		
9	Street watering.....	49,755 36		
9	Stone street crossings, construction of	423 67		
10	Scavenging	58,324 23		
10	Wooden crossings, repairs and maintenance	1,593 21		
			351,146 57	
	SPECIAL WORKS.			
10	Ashbridge's Bay dredging.....	703 50		
11	" improvement.....	28,648 20		
11	Dredging sewage at slips	3,098 24		
11	Don River improvement..... ..	18,084 12		
11	Engine and boiler for sawing blocks..	574 34		
11	Esplanade agreement.	270,640 91		
12	Frederick Street wharf repairs and extension	551 68		
12	Garrison Creek sewer, Ossington to Bloor	8,371 89		
12	Level crossings.....	2,929 38		
12	Relief Sewers:			
	Queen Street, Don to DeGrassi....	12,031 65		
	" Markham to Garrison Creek	2,477 00		
12	Rosedale Creek sewer	12,460 80		
12	Sewer extension to Windmill Line...	4,576 89		
13	Sewer under railroad track, Simcoe Street	5,026 94		
13	Sewer under railroad track, Bathurst Street	1,867 91		
13	Strengthening Queen Street bridge at the Don	3,800 00		
13	Siding at the Don	2,003 00		
			377,846 45	
14	Railway pavements account, per list, pp 17.	. .....	392,030 17	
	Carried forward	.....	1,121,023 19	

For Abstract of Charges see Page	ACCOUNT.	$ c.	$ c.	$ c.
	Brought forward.	....	1,121,023 19	
	Local improvements :			
14	Pavements, per list, pp. 18.....	102,316 50		
15	Sewers " 20.....	9,899 32		
15	Sidewalks, wooden, per list, pp.21.	32,691 13		
15	" patent " 24.	10,436 04		
16	Gradings, extensions, bridges, etc..	31,043 74		
			186,386 73	
	Personal and departmental accounts outstanding December 31st, 1893..	....	18,734 52	
				1,326,144 44

DETAILS.	$ c.	$ c.	$ c.
REPAIRS AND MAINTENANCE OF BRIDGES.			
Lumber, 25,446 ft. B M	357 17		
5-inch nails (125 lbs., $3.45), 7-inch spikes (300 lbs., $7.99)	11 44		
Gravel, 66 yards	62 70		
Hack hire, $2.50; lamps, $4.00; oil and can, $1.75	8 25		
Strachan Ave. and Queen Street bridges (proportion)	369 35		
Electric light at Don bridge	2 97		
Labor	815 35		
			1,627 23
ENGINEERING AND EXPENSES.			
Horse keep, horse hire, horse shoeing and veterinary services	995 25		
Buggy and harness repairs	300 47		
Type writing, engineering and general office expenses	445 02		
Maps, mounting, plans, etc	654 75		
Rent of telephones and telephone supplies	48 29		
Postage stamps, cards, rubber stamps, and petty expenses	391 08		
Cab hire, car tickets and sundry expenses	552 18		
Levels, rods, rules and repairs	373 60		
Machine for testing asphalt	31 50		
Advertising	1,607 95		
Expenses *re* street railway	301 00		
" asphalt pavements	109 20		
" Ashbridge's Bay	15 15		
" Dundas Street bridges	50 00		
Salaries, Engineering staff	36,428 95		
		42,304 39	
Cr.			
Charged local improvement works:			
Sewers	615 68		
Sidewalks	1,866 78		
Pavements	6,759 00		
Railway pavements	7,140 78		
		16,382 24	
			25,922 15
REPAIRS AND RECONSTRUCTION OF KERBS.			
Cedar kerbing, 11,962 ft	145 03		
Cedar posts (16½ cords, $90.40), blocks (¾ cord, $4.61)	95 01		
Lumber (44,223 ft., $609.90), tamarac (6,144 ft., $88.09)	697 99		
Scantling 441 ft., $5.52, unloading cedar, $3.00	8 52		
Carried forward	946 55		27,549 38

	$ c.	$ c.	$ c.
Brought forward	946 55		27,549 38
5-inch nails (1,295 lbs., $35.91), 7-inch spikes, $3.03	38 94		
Rent of shed, $21.00; sundry hardware, $32.51; oil, $9.73	63 24		
Water works charges, $21.56; 1 ton coal, $5.75	27 31		
Labor	1,823 60		
			2,899 64
GENERAL PURPOSE.			
Manholes, covers, culvert grates, track grates, manhole steps, etc	746 04		
Traps, gullies, syphons, culvert tops, flush tanks, flush traps, etc	1,192 41		
Pipe, 4,520 feet	1,134 55		
Inverts, junctions, bends, curves, etc	250 26		
Cement, 556½ bbls., and hauling	1,253 86		
Bricks, 172,447	1,319 50		
Sand and gravel, 423½ yards	414 27		
Stone and macadam	65 00		
Cedar blocks and posts, 12¼ cords	71 44		
Lumber (35,708 ft., $541.88), nails (1 keg, $2.00)	543 88		
Iron bars, girders, old rails and galvanized iron	96 60		
Cement moulder, testing apparatus and patterns	327 32		
Sharpening tools, testing and repairing syphon	45 81		
Hose and couplings, rubber boots, coats and stamps	377 55		
Horse keep, horse shoeing, 1 horse, harness and buggy repairs	589 07		
Rent of yards, rent of telephones, rent of cellars	260 50		
Copperas for sewage treatment, 86,916 lbs.	651 89		
Salt and salt bags, sulphur and soap, lard	22 42		
Sundry hardware	592 97		
Oil, coal, pumps, pails and repairs	133 90		
Street numbers and tablets	19 71		
Stencils and stenographic supplies, paint and ink	92 94		
Maps and mounting, framing photos, etc	24 80		
Building trap on Broadview Ave	12 00		
Opening drain on Spencer Ave	5 30		
Digging oven and smoke testing drain	24 92		
Car tickets, postage stamps, boat hire, etc	243 00		
Tin sheething and gas fitting carpenter shop	116 08		
'Bus sleighs and stores for cabmen's shelter	156 87		
Tin floats, duck, etc., for lake currents	60 00		
Removing dead horses (7)	14 00		
Carried forward	10,858 86		30,449 02

	$ c.	$ c.	$ c.
Brought forward	10,858 86	.....	30,449 02
Law expenses *re* Ashbridge's Bay	232 05		
Water Works charges	123 28		
Inspection on private drains	1,610 00		
Labor	26,622 55		
		39,446 74	
Cr.			
Amounts paid Treasurer:			
Use of sewer on Avenue Road	20 00		
Removing earth and gravel	4 50		
Lumber	493 35		
		517 85	
			38,928 89
PRIVATE DRAINS.			
Pipe, 16,854 feet	1,595 28		
Junctions, bends, reducers, etc	69 56		
Cement, 77 bbls	195 45		
Sand, gravel and hauling	4 68		
Traps	14 26		
Lumber, 3,927 feet	59 10		
Nails, lamps, oil, hardware, etc	60 39		
Water Works charges	36 02		
Rent of Portland Street yard	100 00		
Cleaning out cellars and private drains	69 41		
Repairing pavements on sundry streets	145 26		
Refunds of deposits orders to Treasurer	637 20		
Inspection	1,894 00		
Labor	7,184 07		
		12,064 68	
Cr.			
Amount of deposits paid Treasurer		11,266 84	
			797 84
ROADWAYS.			
Macadam, 3,864 loads	5,754 94		
Cobble stone, 59 cubic yards	84 34		
Broken stone, 58 loads	108 26		
Granite setts, 3,401 only	277 78		
Stone screenings, 93½ cubic yards	45 63		
Crossing stone, 232 feet	90 48		
Limestone, 32 cubic yards	15 00		
Gravel and sand, 5,169¼ yards	4,165 71		
Loam, 110 yards	80 68		
Cement, 203½ bbls	1,226 27		
Cedar blocks and posts, 884 cords	5,413 56		
Miscellaneous lumber, 24,721 feet	390 08		
Cedar kerbing, 880 feet	10 71		
Rent of wharf and yards	542 38		
Rubber hose and couplings	278 95		
Carried forward	18,484 77	.....	70,175 75

	$ c.	$ c.	$ c.
Brought forward	18,484 77		70,175 75
Bricks, fire clay and testing bricks	17 70		
Bench mark plates, bolts, oil, etc	242 80		
Horse blankets, harness trimmings and horse keep	116 94		
Horse feed and straw	885 63		
Electric light at crematory	27 37		
Block carts and hauling blocks	115 50		
Proportion of planer and band sawing machine	428 87		
Wells' lamp, set of scales, fire extinguishers, etc	179 75		
Water Works charges	19 63		
Retaining fees *re* pavements	132 00		
County of York award	756 00		
Land damages *re* Woodlawn Avenue	1,643 95		
Charges on account local improvement pavement after passing of By-law	72 50		
Sundry hardware, and travelling expenses	274 74		
Labor	28,923 57		
		52,315 72	
Cr.			
Granite setts collected from sundry streets (51,640)	4,088 60		
Amount paid Treasurer for paving lane rear of Yonge Street	123 90		
Amount paid Treasurer for repairing areas	28 93		
" " putting gravel on lane	3 25		
Amount paid Treasurer for scrap iron	24 00		
		4,268 08	
			48,047 64
RECONSTRUCTION OF CEDAR BLOCK PAVEMENTS.			
Cedar blocks, $1,402\frac{106}{125}$ cords	8,989 73		
Cedar posts, $4\frac{3}{4}$ cords	26 12		
Lumber, 24,482 feet	366 25		
Cedar kerbing, 30,072 feet	363 25		
Gravel, sand and loam, $2,089\frac{1}{2}$ yards	1,839 63		
Granite setts, 6,122 only	489 76		
Macadam, 481 loads	390 28		
Broken stone, 4 toise	52 00		
Cement, 49 bbls.	122 50		
Bricks, lime, coal and creosote	177 23		
Iron bars, spikes, nails, etc	193 80		
3 track gulley grates	34 23		
Gearing, pulleys and belting	119 38		
Electric lights	81 27		
Repairing gas fixtures, Western Stable	11 05		
Horse hire, horse pasture, veterinary services, etc	222 22		
Carried forward	13,478 70		118,223 39

	$ c.	$ c.	$ c.
Brought forward	13,478 70		118,223 39
Wood preservative, 6 casks	60 00		
Rent of yards and stables	220 50		
Fire insurance on boiler	20 00		
Water Works charges	43 58		
Repairing pavement, Queen Street east	33 10		
Labor	16,173 11		
			30,028 99
SIDEWALKS.			
Lumber, 503,302 feet	5,905 28		
Spikes and nails, 19,806 lbs	561 02		
Cedar posts and blocks, 3½ cords	20 55		
Gravel and sand, 13½ yards	10 33		
Cement and hauling, 15 bbls	38 54		
Cedar kerbing, 9,899 feet	118 81		
Macadam, 62 loads	116 64		
Granite setts, 4,367	349 36		
Horse keep, harness trimmings, etc	103 90		
Grading lines, tape lines, oil, coal, etc	301 40		
Rent of yards, siding and telephones, proportion	681 71		
Old rail, 12,746 lbs	89 12		
Proportion of planer, band sawing machine and belting	163 32		
Major saw	50 00		
Plowshare, steel tank and attachments	110 72		
Advertising	28 50		
Creosote and fire extinguishers	57 00		
Moving safe from Eastern yard	14 95		
4 old lorries	225 00		
Revising Goad's Atlas	10 00		
Expert evidence and photos of Church of the Redeemer	12 30		
Flooring and sheating Eastern Yard	1 10		
Water Works charges	73 80		
Inspection on sidewalk at Custom House	60 00		
Labor	14,577 90		
		23,681 25	
Cr.			
Amount paid Treasurer for sidewalk extensions		1,032 25	
			22,649 00
STREET CLEANING.			
Brush wire, reeds, chains and links	523 31		
Nuts, iron bars, steel, metal and paint mill	81 72		
Buckets, iron shovels, castings, broomheads, etc	108 93		
Signboards, duck bags, paint, varnish, oil, etc.	46 94		
Carried forward	760 90		170,901 38

	$ c.	$ c.	$ c.
Brought forward	760 90		170,901 38
Horse hire, horse blankets, harness trimmings, and repairs	78 91		
One horse, $80; horse feed and straw, $585.69	665 69		
Lumber, nails, sundry hardware, coal and pitch	320 19		
Machine work on tools, proportion of machinery	219 84		
Axles, spokes, hubs, springs, gearing and repairs	134 76		
Broom sections, asphalt brooms and scrapers	65 25		
Photographing dump carts	8 00		
Removing night-soil	2 50		
Posting bills re ice and snow	30 00		
Labor	67,919 31		
		70,205 35	
Cr.			
Amount paid Treasurer for pound fees		56 65	
			70,148 72
STREET WATERING.			
Horses, 9, $835; horse hire, $586.95; blankets and covers, $63.03	1,484 98		
Horseshoeing, horse nails, horse shoes, hoof stuffing	119 33		
Horse feed and straw, $9,470.60; veterinary services, $223.25	9,693 85		
Harness leather and trimmings	989 97		
Carts, hubs, springs, axles, spokes and repairs	473 57		
Sprinklers, 18 setts	306 00		
Lumber, 31,306 ft	985 69		
Branch pipes, hose, forks, bolts, screws, etc.	223 80		
Castings, rings, paint, oil, coal and wood, etc.	548 32		
Proportion of machinery	227 00		
Brushes, combs, pails, sulphur, resin, lime, etc.	105 19		
Iron bars, steel, freight, sundry hardware	546 68		
Fire extinguishers, electric light at Crematory	128 45		
Rent of telephone and removing night-soil	43 50		
Use of water	25,000 00		
Labor	9,396 23		
		50,272 50	
Cr.			
Amount paid Treasurer: pound fees, $10.87; horse keep, $506.33		517 20	
			49,755 30
STONE STREET CROSSINGS.			
Cobble stone, granite setts and gravel	38 63		
Lumber and cedar blocks	19 17		
Carried forward	57 80		290,805 46

	$ c.	$ c.	$ c.
Brought forward	57 80		290,805 46
Nails, paint and tapes	10 15		
Labor	355 72		
			423 67
SCAVENGERING.			
Lumber, cart spokes, hubs and axles	416 88		
Iron bars, iron castings, nuts and bolts	101 13		
Leather, harness, harness trimmings, etc	295 56		
One horse, horse-shoeing, and removing dead horses	168 00		
Horse blankets and covers, and horse feed and straw	3,496 77		
Chains, signs for carts and repairs to carts	52 50		
Proportion of machinery	57 00		
Veterinary services, sundry hardware and removing night-soil	97 68		
Coal, wood and electric light at Crematory	87 98		
Rakes, grease, oil, tarpaulin and paint	42 19		
Labor	54,152 04		
		58,970 73	
Cr.			
Horse keep, sundry Departments	499 00		
Amount paid Treasurer for pound fees	69 75		
" " 4 dump carts	44 00		
" " 2 horses	22 50		
" " removing garbage	11 25		
		624 50	
			58,324 23
WOODEN CROSSINGS.			
Plank, 46,068 ft	598 39		
Tamarac, 16,896 ft.	244 99		
Scantling, 3,219 ft	41 47		
Nails and spikes, 4,400 lbs	132 91		
Rent of Marion Street yard	37 50		
Labor	537 95		
			1,593 21
ASHBRIDGE'S BAY DREDGING.			
Lumber, shovels, axes, rubber boots, etc	46 56		
Boat hire, sounding rod, and advertising	25 80		
Deputation to Ottawa	159 25		
Expert evidence and copping evidence	197 10		
Taxed costs *re* Coleman	48 64		
Inspection	60 00		
Labor	166 15		
			703 50
Carried forward			351,850 07

	$ c.	$ c.	$ c.
Brought forward			351,850 07
ASHBRIDGE'S BAY IMPROVEMENTS.			
Lumber, nails and iron	749 68		
Removing sand and teaming	79 14		
Digging cut at foot of Leslie Street	513 64		
Tug and boat hire	107 00		
Boat, rent of boat-house, and paint	42 50		
Hack hire and sundry hardware	46 98		
Damages and fees in Coleman suit	2,384 05		
Contract work	21,937 94		
Labor	1,991 02		
Inspection	796 25		
			28,648 20
DREDGING SLIPS.			
Contract work	2,761 87		
Inspection	192 00		
Labor	144 37		
			3,098 24
DON RIVER IMPROVEMENT.			
Land and damages	13,020 97		
Law expenses	4,594 82		
Evidence	256 83		
Labor	211 50		
			18,084 12
ENGINE AND BOILER FOR SAWING BLOCKS.			
Chain, files and leather	21 72		
Oil, and sharpening saws	82 63		
Labor	469 99		
			574 34
ESPLANADE AGREEMENT.			
Bricks, stone, sand, gravel and blocks	404 27		
Pipe, lumber and nails	42 09		
Cement, 295 bbls	744 50		
Hauling cement, boat hire and sundry hardware	242 35		
Tape lines, chain, saw cutting, etc	74 15		
Travelling expenses, Ottawa and Montreal	51 25		
Lithographing plans	47 50		
Advertising	173 50		
Water Works charges	4,738 31		
Inspection	1,179 00		
Labor	421 66		
Valuation fees	1,550 00		
Land and damages	205,201 75		
Contract work	55,770 58		
			270,640 91
Carried forward			672,895 88

	$ c.	$ c.	$ c.
Brought forward			672,895 88
FREDERICK STREET WHARF REPAIRS AND EXTENSION.			
Labor			551 68
GARRISON CREEK SEWER, OSSINGTON TO BLOOR.			
Land and damages	4,078 68		
Arbitration fees and evidence	1,822 37		
Drawback on account of contract	2,470 84		
			8,371 89
LEVEL CROSSINGS.			
City's proportion paid C.P.R	1,313 74		
" " " G.T.R	1,615 64		
			2,929 38
RELIEF SEWERS.			
Queen Street, Don to DeGrassi.			
Pipes, bends, elbows and traps	61 83		
Labor	2 00		
Inspection	363 50		
Contract work	11,605 32		
			12,031 65
Queen Street, Markham to Garrison Creek.			
Inspection	182 00		
Contract work	2,295 00		
			2,477 00
ROSEDALE CREEK SEWER.			
Boat hire, $3.55, pipe, 84c.; inspection, $10.50	14 89		
Contract work and costs, as per award	12,445 91		
			12,460 80
SEWER EXTENSION TO WINDMILL LINE.			
Steel and iron pipe	1,005 20		
Lumber, 8,616 feet	148 32		
Spikes and spokes	31 26		
Lithographing plans and conveyancing	145 00		
Unloading pipes and rubber gloves	14 75		
Inspection and labor	279 88		
Contract work	2,952 48		
			4,576 89
Carried forward			716,295 17

	$ c.	$ c.	$ c.
Brought forward			716,295 17
RECONSTRUCTION OF SEWERS UNDER RAILROAD TRACK.			
Simcoe Street.			
Lumber, 39,988 feet	611 48		
Nails, pipe, gravel and sand	181 89		
Bricks, 94,000	685 30		
Cement, 320 bbls., and hauling same	832 08		
Smoke stack, pails, tape line, hose and couplings	41 35		
Crossing stone, manhole tops and sundry hardware	33 71		
Grand Trunk Railway, account for putting in stringers	61 25		
Labor	2,579 88		
			5,026 94
Bathurst Street.			
Lumber, 7,019 feet, and nails	113 14		
Bricks, 20,000; sand and gravel, 98 yards	238 60		
Cement, 147 bbls., and hauling same	371 90		
Labor	1,144 27		
			1,867 91
STRENGTHENING QUEEN STREET BRIDGE AT THE DON.			
Lumber and nails	656 71		
Cedar posts and blocks	90 72		
Notice boards and hardware	27 08		
Inspection and labor	774 75		
Contract work	2,250 74		
			3,800 00
SIDING AT THE DON.			
Amount paid Grand Trunk Railway			2,003 00
Carried forward			728,993 02

	$ c.	$ c.	$ c.
Brought forward			728,993 02
SUMMARIES.			
RAILWAY PAVEMENTS.			
Contract work	335,043 10		
Inspection	5,681 50		
Labor	11,621 15		
Castings :			
Round manholes, 74	706 15		
Manhole tops, 42	396 19		
" steps, 283	46 50		
Track gullies and grates, 135	1,421 59		
Culvert tops and traps, 59	511 23		
Pipe, 6, 9 and 12 in., 4,803 ft.	646 19		
Bends, junctions, elbows and slants, 214	147 53		
Lumber, 4,288 ft	71 90		
Bricks, 55,500	386 85		
Cement, 5084 barrels	2,041 55		
Sand and gravel, 1,662 yards	1,559 49		
Granite setts, 15,682	11,614 07		
Scoria blocks, 147,104	8,186 45		
Stone setts, 4,375	329 00		
Crossing and kerb stone, 2,587' 10"	798 96		
Circular kerb stone, 17' 6"	21 88		
Macadam, 11 loads	12 20		
Crushed stone, 4 yards	7 40		
Cedar blocks and posts, 287¾ cords	1,974 41		
Paving pitch, 183 barrels	414 05		
Hauling and teaming	81 45		
Use of pitch kettle	40 50		
Repairing pavements	892 87		
Sundry hardware and sharpening tools	74 38		
Water Works charges	152 80		
Expert evidence	8 05		
Engineering	7,140 78		
			392,030 17
PAVEMENTS.			
Contract work	91,945 39		
Inspection	1,654 25		
Wages	3,266 03		
Engineering	3,077 19		
Water Works charges	211 75		
Pipe, 6 and 9-inch, 536 feet	76 13		
Bends and junctions, 19	10 14		
Cement, 138 barrels	347 10		
Sand and gravel, 281 yards	254 39		
Bricks, 25,295	213 83		
Castings :			
Culvert traps and tops, 49	320 55		
Manhole tops and steps, 74	105 15		
Round manholes and track grates, 5	22 24		
Carried forward	101,504 14		1,121,023 19

	$ c.	$ c.	$ c.
Brought forward	101,504 14		1,121,023 19
Cedar kerbing, 13,441 feet	161 30		
Lumber, 8,216 feet	114 43		
Crossing stone, 826 feet	322 14		
Cedar blocks and posts, 217¼ cords	1,330 89		
Scoria blocks, 620	40 30		
Nails and spikes, 1,465 lbs.	43 12		
Macadam, 4 loads	7 05		
Earth, 109 loads	21 80		
Sodding, 1,780 yards	71 20		
Repairing pavements	195 84		
		103,812 21	
Cr.			
Land damages, charged in error	1,361 73		
Fourteen round manholes, charged to railway pavement account	133 98		
		1,495 71	
			102,316 50
LOCAL IMPROVEMENT SEWERS.			
Contract work	8,300 13		
Inspection	265 81		
Wages	482 53		
Engineering	543 00		
Pipe, 9 and 12-inch, 802 feet	175 39		
Bends, junctions and stoppers, 143	59 14		
Manhole steps, 15	2 48		
Bricks, 1,200	8 94		
Cement, 9 barrels	23 40		
Sand, 5 yards	5 00		
Wood, 5½ cords	33 50		
			9,899 32
LOCAL IMPROVEMENT SIDEWALKS, WOODEN.			
Lumber, 1,632,295 feet	20,816 56		
Nails, 37,948 lbs.	1,051 18		
Cedar blocks and posts, 3½ cords	26 15		
Water Works charges	2,085 28		
Engineering and expenses percentage	1,579 07		
Wages, labor on walks	7,132 89		
			32,691 13
PATENT SIDEWALKS.			
Contract work	9,412 72		
Labor	264 96		
Sodding, 2,077 yards	86 33		
Water Works charges	186 82		
Wages, inspection	197 50		
Engineering and expenses percentage	287 71		
			10,436 04
Carried forward			1,276,366 18

	$ c.	$ c.	$ c.
Brought forward			1,276,366 18
BRIDGES, GRADINGS, EXTENSIONS, ETC.			
Contract work	10,405 60		
Labor	215 26		
Land, damages and witness fees	18,668 02		
Granite setts, 4,296	343 68		
Earth, 152 cubic yards	38 00		
Gravel, 302 yards	295 96		
Lumber, 15,574 feet	272 28		
Culvert top, 1	5 00		
Repairing fence	6 65		
Moving telegraph poles	217 60		
Use of temporary bridge	50 00		
Watchman expenses	47 60		
Raising house at Dundas Street Bridge	400 00		
Rent of field	40 00		
Sundry hardware	38 69		
			31,043 74
Personal and Departmental accounts outstanding December 31st, 1893			18,734 52
			1,326,144 44

RAILWAY PAVEMENTS.

Street.	From.	To.	Dr.
			$ c.
Bloor	Yonge	Dufferin	12,555 92
Bathurst	King	Queen	4,022 87
"	Queen	Bloor	23,010 91
Broadview Ave	"	Danforth	6,950 95
College	Yonge	McCaul	15,246 01
"	McCaul	Bathurst	21,952 02
"	Bathurst	Dufferin	26,550 95
"	Dufferin	Lansdowne	8,336 71
Carlton	Yonge	Parliament	19,714 55
Church	Front	Bloor	22,908 18
Dundas	Queen	The bend	9,350 02
"	Arthur	Jamieson	19,340 24
"	Sorauren	Bloor	10,449 48
Front	Frederick	Sherbourne	238 05
"	"	Church	12,151 31
"	Church	Simcoe	17,484 70
Frederick	King	Front	2,060 15
George	"	"	1,576 67
Gerrard	Pape	River	19,742 84
"	River	Parliament	7,800 88
High Park Ave	Roncesvalles	High Park	7,479 45
Howard Park Ave	"	Dundas	3,353 37
Jamieson Ave	College	"	2,082 07
King	River	Sherbourne	2,079 80
"	Sherbourne	Simcoe	7,033 32
"	Simcoe	Bathurst	1,147 87
"	Bathurst	Strachan	899 65
"	Dufferin	Roncesvalles	2,560 15
Parliament	Queen	Gerrard	13,706 40
"	Gerrard	Carlton	5,070 05
"	Carlton	Winchester	2,471 57
Queen	East City limits	G.T.R	11,912 47
"	G.T.R	Davies Ave	1,248 80
"	Davies Ave	River	824 26
"	River	Yonge	32,760 41
"	Yonge	Bathurst	2,351 57
"	Bathurst	Roncesvalles	6,517 43
Sherbourne	Front	King	319 09
Spadina Ave	Queen	Bloor	3,544 50
Winchester	Parliament	Sumach	5,561 30
York	Front	Queen	11,231 29
Yonge	"	King	3,342 91
"	King	Bloor	1,539 98
"	Bloor	C.P.R	1,549 05
			392,030 17

LOCAL IMPROVEMENT PAVEMENTS.

Street.	From.	To.	Dr.
			$ c.
ASPHALT:			
Czar	Yonge	North	4,727 12
Earl	Sherbourne	West end	4,022 60
Lane in rear of Canada	Permanent Buildings.		873 95
Linden	Sherbourne	Huntley	4,919 11
Munn's Lane	Wellington	218 feet north	1,205 06
Richmond	Victoria	Bay	9,781 95
Winchester	Parliament	Sumach	11,418 52
CEDAR & COBBLE:			
Bleeker	Wellesley	Howard	2,090 47
Churchill	Terminus	136 feet east	369 78
Dundas	Sorauren	Bloor	7,308 10
Edmund	Royce	C.P.R	595 69
Euclid Place	Euclid Ave	East terminus	229 22
High Park Ave	Roncesvalles	High Park	4,736 88
Huron	Phœbe	Grange	1,712 81
Mansfield Ave	Manning	Christie	745 21
"	Bellwoods	Grace	542 79
Northumberland	Ossington	Preston	575 41
Olive Ave	Bathurst	Palmerston	1,479 92
Perth Ave	Bloor	Royce	7,083 81
Royce Ave	Symington	C.P.R	3,780 56
Sorauren Ave	Old boundary Parkd'le	Dundas	812 25
South Drive	Crescent	Centre	5,530 78
Shaw	College	Bloor	6,173 68
Victoria Cres	Dunn	Jamieson	2,851 11
Walmer Road	Bernard	Dupont	1,366 79

COMPLETED PRIOR TO 1893.

Bruce	Shaw	Givens	44 30
Barton	Palmerston	Euclid	62 40
Dupont	Manning	Bathurst	131 65
Delaware Ave	Bloor	Van Horne	25 00
"	College	Bloor	1,099 70
Evans Ave	Clinton	West terminus	102 47
Grace	Arthur	College	238 25
Halton	Shaw	Dundas	77 29
Herrick	Bathurst	Lippincott	64 00
King	Sherbourne	Simcoe	13,021 11
Lanes.			
Lane between	Pearl	Adelaide	13 50
"	Mutual	Jarvis	21 50
First east of Spadina	Grange	St. Patrick	28 80

PAVEMENTS—*Continued.*

Street.	From.	To.	Dr.
			$ c.
Bet. Yonge & Victoria	Adelaide	106 feet south	14 40
Off Jordan	Jordan	West terminus	75 10
Bet. York & Simcoe	Pearl	North terminus	74 80
Rear of John	Adelaide	Lane r'r Arlington Hotel	465 27
South of Queen	Tecumseth	Niagara	528 22
Bet. St. Patrick & D'Arcy	Beverley	Huron	31 52
Logan Ave	Queen	Gerrard	304 50
Lombard	Victoria	Jarvis	311 00
Lowther Ave	Brunswick	Howland	27 85
Lucas	Saurin	Roncesvalles	324 80
Montague Place	Homewood	West terminus	106 66
Ossington Ave	Bloor	C.P.R	790 90
O'Hara Ave	Terminus	Railway track	57 91
Rossin House Lane	York	East terminus	37 86
Roxborough Av	Yonge	1,328 feet west	598 90
Wyatt Ave	Sumach	River	65 00
			103,678 23
Less land damages	charged in error		1,361 73
			102,316 50

LOCAL IMPROVEMENT SEWERS.

Street.	From.	To.	Dr.
			$ c.
Avondale Road	Terminus	100 ft. east Rosedale	120 12
Avenue Road	Tannery Hollow	North City limits	130 00
Barton Ave.	Bathurst	Euclid	85 20
"	Manning	Christie	241 00
Centre Road	Roxborough	North Drive	20 25
Carlyle	Perth	West end	25 65
Clinton	Barton	Yarmouth	2,231 37
College	Roncesvalles	Soraaren	153.50
Dupont	Manning	Christie	57 15
"	St. George	Huron	45 30
Emerson Ave	Wallace	Bloor	251 60
Edwin	Royce	C.P.R.	63 95
Gerrard	Broadview	The Don	94 55
Glen Road	Elm	Maple	137 50
Hazelton Ave	Yorkville	Davenport	537 28
Lane off Dufferin	Alma	Waterloo	18 00
Lane rear of Portland	Adelaide	Farley	709 96
Liberty	Atlantic	Pacific	51 90
Lynd	Dundas	College	96 95
Monk	Bathurst	Markham	21 05
Markham	Olive	Vermont	79 33
O'Hara Ave.	Terminus	Railroad track	22 90
Pine Hill Road	Rosedale	West terminus	40 32
Rosedale Road	Park Road	Pine Hill Road	44 90
Roxborough	Terminus of sewer	Avenue Road	73 64
Rosebery Ave.	Bathurst	325 feet east	490 00
Sully	College	Garrison Creek	59 61
St. Helen's Ave.	"	Bloor	882 59
St. Clarens Ave.	Wallace	"	577 40
Tyndall Ave.	Huxley	G.T.R.	27 40
Wallace Ave.	McKenzie	Grogan's Line	2,589 38
			9,979 75
	Cr.		
Lane north of Elm	Teraulay	East terminus	80 43
			9,899 32

LOCAL IMPROVEMENT SIDEWALKS.

Street.	Side.	From	To	Dr.
				$ c.
WOODEN:				
Adelaide	North	56 ft. w. of Victoria.	Yonge	113 22
Albert	South	Yonge	James	122 00
Addison Av.	"	Perth	West terminus	67 79
Ann	North	Church	Mutual	99 79
Anderson	"	71 ft. e. of McCaul.	Simcoe	85 34
"	South	McCaul	William	48 47
Avenue Rd.	West	111 ft. n. Davenport	Chicora	106 37
Avenue Lane	South	Chestnut	University	90 83
Arthur	North	Palmerston	Euclid	95 04
Alice	"	Yonge	Teraulay	201 72
Balmuto	West	Czar	115 ft. north	33 66
Bathurst	"	Queen	Arthur*	530 30
Baldwin	South	Huron	Spadina	135 80
Bedford Rd	West	Bernard	380 ft. south	110 97
Bellevue Av	"	Bellevue Pl	Nassau	285 96
Bernard "	South	Bedford Rd	150 ft. west	44 70
Bellwoods"	East	Queen	Treford	876 44
Beaconsfield Av.	West	Saurin	Dundas	337 18
Bishop	North	Davenport Rd.	296 ft west	56 11
"	South	"	West end	80 85
Bloor	"	Balmuto	263 ft. west	72 67
"	North	Brock	McKenzie	410 32
Brunswick Av	Both	Ulster	Bloor	1,470 02
Brant	East	Farley	Adelaide	125 43
Carr	South	Esther	West end	404 64
Carlton	"	Seaton	Ontario	68 02
College	North	130 ft. east of Rushholm Rd	Dovercourt	55 38
"	"	University Cres.	Queen's Park	328 91
"	Both	Yonge	University	1,232 27
Classic Av.	North	Spadina	Huron	6 32
Church	East	Carlton	Wood	34 90
Charles	North	Yonge	Church	261 10
Chestnut	West	Elm	136 ft. south	37 09
"	"	"	Christopher	174 88
Clarence Sq	South	Spadina	East end of Square.	142 39
Close Av	East	King	Queen	432 97
Cherry	West	Mill	Front	108 92
Churchill Av	Both	194 ft. e. Lakeview.	161 ft. east and 174 ft. on south side.	95 88
Czar	North	North	Balmuto	90 71
"	"	"	The Park	135 78
D'Arcy	South	Beverley	McCaul	248 76
Dovercourt Rd.	West	Queen	Argyle	12 97
Dowling Av	"	King	G. T. R.	198 49
Dundas	South	St. Clarens	Lansdowne	97 97
"	West	68 ft. n. of Humbert	Argyle	107 04
"	North	Bloor	Sorauren	793 49

LOCAL IMPROVEMENT SIDEWALKS -*Continued.*

Street.	Side.	From	To	Dr.
				$ c.
Duke	"	George	454 ft. east	132 51
"	"	Sherbourne	Ontario	173 14
Drummond Pl	East	1st lane n. Adelaide.	North terminus	21 61
Emerson Av	"	Bloor	Wallace	309 25
Eastern Av	North	Sumach	St. Lawrence	151 92
"	"	Trinity	Sackville	133 68
Esther	East	Queen	St. Patrick	400 48
Edward	North	Yonge	University	409 33
Esplanade	"	Frederick	Sherbourne	85 51
"	"	Sherbourne	Berkeley	276 11
Elm Av	"	Huntley	Terminus	49 02
Euclid Av	East	Arthur	426 ft. north	235 65
"	West	"	616 ft. "	265 24
First Av	North	DeGrassi	237 ft. east	3 53
"	"	Logan	644 ft. west	248 61
Front	"	Princess	Berkeley	185 41
"	"	Sherbourne	Frederick	80 49
Francis	Both	King	Adelaide	184 91
Gerrard	South	Bolton	Broadview	279 31
"	North	Howland	"	372 81
Gordon	"	Dufferin	Sheridan	177 14
Golden	West	Dundas	North end	149 75
Gould	North	Yonge	Victoria	93 95
Gloucester	"	100 ft. e. of Yonge	Church	286 07
Harbord	South	Bathurst	Brunswick	312 49
Hill	"	South Drive	Glen Rd	129 64
Howard	"	Sherbourne	Bleeker	62 07
Huron	West	Phoebe	Grange	232 54
"	East	Spadina	D'Arcy	85 83
John	"	King	Wellington	131 56
King	North	19 ft. west of Brant.	Tecumseth	26 53
"	"	82 ft. east of Ontario	150 ft. west	128 17
"	"	Berkeley	257 "	133 70
"	"	Simcoe	John	282 82
"	"	Spadina	Peter	192 71
"	"	Peter	Widmer	14 64
"	South	Sherbourne	Berkeley	507 33
"	"	Simcoe	100 ft. east of Dorset	169 36
"	"	Berkeley	Parliament	156 93
"	"	Parliament	Erin	153 00
"	"	Trinity Pl.	Sackville	175 91
"	"	Jameson	Dowling	169 53
Lippincott	East	Nassau	Oxford	132 60
London	North	Markham	Euclid	155 92
Louisa	"	Elizabeth	246 ft. east	68 19
Logan Av	East	Gerrard	Bain	197 55
Massey	"	Wellington	King	122 14
Marlborough	North	Yonge	428 ft. west	164 95
Manning Av	West	College	Harbord	789 45
Markham	East	Bloor	London	140 19

LOCAL IMPROVEMENT SIDEWALKS—*Continued.*

Street.	Side.	From	To	Dr.
				$ c.
May	West	Hill	May Pl.	92 64
Manning Av	East	Arthur	College	640 39
McCaul	West	St. Patrick	D'Arcy	100 21
"	"	Queen	Grange	219 80
McKenzie	East	Wallace	112 ft. south	25 47
McMillan	West	Alexander	Maitland	65 61
Mitchell	South	Tecumseth	Niagara	276 04
Niagara	East	Wellington	King	132 96
"	West	Queen	Defoe	248 89
Ord	North	Murray	282 ft. west	54 69
"	South	"	276 "	53 87
Ontario	West	Duke	Duchess	114 09
Park Rd	North	Reynolds	Woodland	349 78
Pape	East	Queen	Eastern	253 07
Parliament	"	Oak	180 ft. s. Wilton Av.	212 59
"	West	Sydenham	21 " "	313 92
Palmerston	"	Robinson	Arthur	561 20
Pearl	North	York	East end	120 25
Perth	East	Irving	325 ft. south	71 92
Queen	South	Parliament	Power	5 25
"	"	Dunn	Dowling	398 97
"	"	Bathurst	Tecumseth	371 10
"	North	Strachan Av	47 ft. east of Dundas	38 45
Rose Av	East	Howard	450 ft. south	127 83
Rosedale Rd	"	Avondale	North Drive	167 53
"	S-West	"	Park Rd	188 43
Roseberry	South	Bathurst	East end	78 51
Rusholme Rd	East	Dundas	St. Ann	292 67
Sackville Pl	North	Sackville	156 ft. east	29 43
Simcoe	West	Richmond	Adelaide	123 26
"	"	226 ft. n. of Queen	Anderson	347 17
"	"	King	Adelaide	114 07
"	East	"	43 ft. north of Pearl	81 83
Symington	West	Bloor	South terminus	186 32
Shaw	"	240 ft. n. of College	Bloor	735 47
Shuter	North	Bond	Church	101 82
"	"	Jarvis	Mutual	70 34
Spadina	West	Adelaide	290 ft. south	83 09
Stephanie Pl	North	John	210 ft. east	75 59
Starr	Both	Dunn	Victoria Cres	364 83
Sherbourne	West	King	Duchess	244 79
"	East	"	"	215 36
St. Patrick	North	Spadina	Huron	138 32
"	"	Beverley	McCaul	183 87
St. Joseph	South	St. Vincent	653 ft. west	174 18
St. Nicholas	West	Inkerman	Czar	78 36
Terauley	East	Walton	131 ft. n. of Gerrard	66 57
"	"	Agnes	Edward	76 30
"	West	Gerrard	Hayter	83 85
Temperance	North	Yonge	Bay	156 95

LOCAL IMPROVEMENT SIDEWALKS—*Continued.*

Street.	Side.	From	To	Dr.
				$ c.
Turner	Both	Niagara	Walnut	105 65
Trinity Sq	South	Yonge St. Lane	107 ft. west	31 49
Union	North	Lansdowne	Macdonnell	75 95
Victoria	West	240 ft. s. of Gould	Queen	338 33
"	East	Richmond	137 ft. south	76 48
Victoria Cres	Both	Dunn	Jameson	470 06
"	North	Jameson	392 ft. west	107 56
Water	West	Mill	Front	63 38
Walmer Rd	East	Bernard	150 ft. north	132 03
Walter	South	McMurrich	Davenport Rd	77 36
Wellesley	"	Jarvis	300 ft. east	86 53
Wellington	"	Stafford	540 "	142 33
Wilton Av	North	Parliament	Sumach	358 09
"	"	Yonge	Bond	164 28
Winchester	"	Rose Av	Parliament	93 96
Wilcocks	South	Robert	Spadina	114 92
Wilson	North	Broadview	291 ft. east	10 88
Woolsley	Both	Bathurst	Esther	625 48
Wood	North	Church	McMillan	91 35
Wyndham	"	Brock	St. Clarens	6 11
				32,691 13

PATENT SIDEWALKS.

EUREKA:				
Queen	North	Bathurst	Palmerston	130 08
Sherbourne	East	Gerrard	Wellesley	2,624 75
"	West	Wilton Av	Bloor	5,600 96
EXCELSIOR:				
College	South	Markham	Augusta	485 21
"	North	Borden	Palmerston	412 63
Church	East	Adelaide	Queen	246 08
Carlton	North	Yonge	Bleecker	550 84
Queen	"	"	James	99 91
STONE:				
Victoria	Both	King	Adelaide	285 60
				10,436 04

BRIDGES, GRADINGS, EXTENSIONS, OPENINGS, ETC.

Works.	Dr.
	$ c.
Dundas Street Bridges	21,619 62
Rosedale Valley Road opening	1,375 74
Goldring and Monk Street extensions	480 00
Crawford Street extension	5 00
McMillan Avenue "	6,600 00
Sunnyside " "	963 38
	31,043 74

APPENDIX "B."

WATER WORKS DEPARTMENT.

CHIEF CLERK'S STATEMENT.

CITY ENGINEER'S OFFICE,
WATER WORKS BRANCH.

December 31st, 1893.

E. H. KEATING, ESQ.,
City Engineer:

DEAR SIR,—I attach statement showing expenditure on account of Water Works Department for the year ending December 31st, 1893, also Schedules showing work performed at the Pumping Stations and other branches of the Department during the year.

Yours obediently,

CHAS. A. MATTHEWS,
Chief Clerk.

SCHEDULE No. 1.

STATEMENT OF REVENUE AND EXPENDITURE FOR THE YEAR 1893.

RECEIPTS.	$ c.	$ c.	$ c.
Sundry persons, water rentals, as per statement of City Treasurer		361,395 82	
Corporation, for water and plant supplied as follows:			
Fire purposes	65,600 00		
Fire halls	1,147 60		
Jail	1,152 58		
Exhibition Buildings	750 00		
Horticultural Gardens	20 00		
Police stations	509 60		
Street watering	25,000 00		
City buildings and public fountains	700 00		
Markets	369 00		
City Registry Office	40 00		
Isolation Hospital	50 00		
		85,338 18	
			446,734 00
EXPENDITURE.			
Working expenses, 1893		166,696 40	
Dr. for coal in stock on 31st December, 1892		15,514 38	
		182,210 78	
Less,			
Cr. by coal in stock on 31st December, 1893	8,691 53		
" coal and screenings sold	412 52		
" receipts from sundry persons for repairs, etc.	7,080 81		
		16,184 86	
Net working expenses		166,025 92	
Interest and sinking fund on Water Works debenture debt		224,732 00	
			390,757 92
Surplus of revenue over working expenses and annual charge for debenture debt			55,976 08

MEMO.—The sum of $130,455 was also provided on capital account out of current revenue to meet cost of renewal of mains and house services, the re construction of the conduit pipe and the necessary extensions of the works.

CASH EXPENDITURE ON MAINTENANCE ACCOUNT, 1893.

ACCOUNT.	On account of 1893.	On account of 1892 Liabilities.	Total.
	$ c.	$ c.	$ c.
Meter and machine shop	10,852 43	159 79	11,012 22
Maintenance distribution	16,332 34	475 81	16,808 15
Main pumping station	100 934 24	1,825 47	102,759 71
Reservoirs, Rose Hill and High Level	7,293 17	109 47	7,402 64
High level pumping station	7,669 27	812 35	8,481 62
Press and store house	6,536 41	84 17	6,620 58
Office	2,582 54	38 70	2,621 24
Insurance, damage claims and miscellaneous	2,665 20	211 06	2,876 26
Cartage	2,495 47	150 45	2,645 92
General stores	5,177 93	158 00	5,335 93
St. Alban's station	36 00	88 63	124 63
New meters	7 50		7 50
Total	162 582 50	4,113 90	166,696 40

CASH EXPENDED ON CONSTRUCTION ACCOUNT, 1893.

ACCOUNT.	On account of 1893.	On account of 1892 Liabilities.	Total.
	$ c.	$ c.	$ c.
Pipe-laying, dead ends	3,519 53	1,168 94	4,688 47
" revenue mains	1,379 62		1,379 62
" By-law No. 2310	5,684 61		5,681 61
" renewals	17,970 70		17,970 70
" special mains	445 04		445 04
" short lengths, special valves, etc.	1,056 80		1,056 80
House services	10,378 32	964 33	11,342 65
" renewals	474 65		474 65
Conduit repairs	15,901 71	53 64	15,955 35
Examination of steel conduit	3,566 48		3,566 48
" wooden conduit	920 47		920 47
Steel lining Hanlan's crib	3,629 45		3,629 45
New pumping engine, No. 4	53,792 42	90 16	52,882 58
" No. 5	2,436 42		2,436 42
Extension of 36-in. pumping main to Front St.	5,828 31		5,828 31
Repairing and re-laying steel intake pipe	7,326 33	37 50	7,363 83
Investigation *re* new water supply	2,504 38		2,504 38
Special branches and connections	3,017 55		3,017 55
Total	138,82 79	2,314 57	141,144 36

SCHEDULE No. 2.

STATEMENT OF WATER PUMPED BY ENGINES NOS. 1, 2, AND 3, FOR THE YEAR 1893.

MONTH.	Number of Days Working.			Number of Hours Working.			Number of Strokes per Month.			Quantity of Water Pumped per Month in Imperial Gallons—Gross.			Total Quantity Pumped by all three Engines. Gross.	Percentage of Slip.	Total Quantity Pumped in Imperial Gallons—Net.	Total Coal used for No. 1, 2, and 3 Engines.*	Average Quantity of Coal Consumed per Day.
	No. 1.	No. 2.	No. 3.	No. 1.	No. 2.	No. 3.	No. 1.	No. 2.	No. 3.	No. 1.	No. 2.	No. 3.					
				h. m.	h. m.	h. m.										tons. lbs.	tons. lbs.
January	27	28	30	Not	Recorded.		427,289	432,948	552,939	97,421,892	198,723,132	268,728,354	564,873,378	5	536,629,710	1,210 50	39 066
February	18	4	25	"	"		273,290	63,260	344,614	62,310,120	29,036,340	167,482,404	258,828,864	5	245,887,421	688 290	24 1,153
March	29	7	25	"	"		472,270	83,512	365,380	107,687,560	38,332,008	177,574,680	323,594,248	5	307,414,536	884 1,950	28 1,095
April	25	26	.....	458 30	458 05	.....	342,003	296,602	.....	77,976,684	136,140,318	.....	214,117,002	5	203,411,152	627 960	20 1,832
May	24	24	13	543 30	402 10	134 20	416,136	258,468	96,065	94,879,008	118,636,812	46,687,590	260,203,410	5	247,193,240	740 1,530	23 1,791
June	30	30	.....	471 55	591 30	.....	365,466	401,105	.....	83,326,248	184,107,195	.....	267,433,443	5	254,061,771	702 1,505	23 850
July	31	31	.....	547 10	607 00	.....	422,540	403,080	.....	96,339,120	185,013,720	.....	281,352,840	5	267,285,198	760 200	24 1,038
August	30	31	16	359 30	563 05	104 00	277,401	388,726	72,215	63,247,428	178,425,234	35,096,490	276,769,152	5	262,930,695	737 1,870	23 1,608
September	27	21	30	483 55	168 35	300 50	395,892	111,831	223,445	90,263,376	51,330,429	108,594,270	250,188,075	4	240,180,552	660 1,515	22 050
October	7	19	25	41 45	304 35	475 10	29,517	200,853	345,199	6,729,876	92,191,527	167,766,714	266,688,117	4	256,020,593	669 915	21 1,190
November	15	9	27	171 55	98 40	538 05	121,621	66,518	363,289	27,729,588	30,531,762	176,558,454	234,819,804	4	225,427,012	573 230	19 207
December	9	6	30	59 05	66 15	610 20	44,856	47,126	425,407	10,217,168	21,630,834	206,747,802	238,595,804	4	229,051,972	601 320	19 784
	272	236	221	3,137 15	3,259 55	2,162 45	3,588,281	2,754,029	2,788,553	818,128,068	1,264,099,311	1,355,236,758	3,437,464,137	....	3,275,493,852	8,856 1,335	....

* Less Coal used for Syphoning and Puddling around the New Engine House ..... 196 tons.
Net Coal used ..... $8,660\frac{1335}{}$ tons.

Average quantity of Water Pumped per Day—Gross ..... 9,417,709 gallons.
" " " Net ..... 8,973,955 "
" " per pound of Coal ..... 189.1 "
" Coal Consumed per Day ..... $24\frac{529}{}$ tons.

SCHEDULE No. 3.

Statement of Water Pumped by Engine No. 4, for the Year 1893.

Month.	Number of Days Working.	Number of Hours Working.		Number of Strokes per Month.	Quantity of Water Pumped per Month in Imp. Gallons. Gross.	Percentage of Slip.	Total Quantity Pumped in Imp. Gallons. Net.	Total Coal Used.		Average Quantity of Coal Consumed per Day.	
		h.	m.					tons.	lbs.	tons.	lbs.
January	13	300	0	622,525	131,352,775	2	128,725,720	195	1,345	6	621
February	25	584	2	1,293,341	272,894,951	2	267,437,053	323	1,575	11	1,127
March	29	628	15	1,331,640	280,976,040	2	275,356,520	384	1,890	12	835
April	29	671	35	1,410,379	297,589,969	2	291,638,170	261	740	8	1,424
May	31	736	55	1,564,760	330,164,360	2	323,561,073	412	1,470	13	628
June	30	657	35	1,392,620	293,842,820	2	287,965,961	359	500	11	1,950
July	31	707	40	1,494,870	314,781,570	2	308,488,879	375	1,455	12	240
August	31	727	25	1,538,575	324,639,325	2	318,146,539	358	380	11	1,109
September	30	716	15	1,492,770	314,974,470	4	302,375,492	375	715	12	1,023
October	31	687	50	1,409,158	297,332,338	4	285,439,045	352	1,855	11	769
November	30	680	20	1,388,232	292,916,952	4	281,200,274	354	1,950	11	1,665
December	31	721	35	1,481,995	312,700,945	4	300,192,907	395	630	12	1,504
Totals	341	7,819	27	16,417,865	3,464,169,515	...	3,370,527,636	4,150	505	.....	

Average quantity of Water Pumped per Day—Gross ..... 9,490,875 imperial gallons.
" " " " Net ..... 9,231,322 "
" " " per Pound of Coal ..... $405\frac{122}{1000}$ "
" Coal Consumed per Day ..... $11\frac{741}{1000}$ tons.

SCHEDULE No. 4.

Record of Water Re-Pumped at High Level Pumping Station during 1883

Month.	Hours Pumped each Month.	Coal Consumed.	Imp. Gallons of Water Re-Pumped each Month. Gross.	Per-centage allowed for Slip.	Net Quantity of Water Re-Pumped. Imp. Gallons.	Average Pressure on Force Main.	Average Number of Hours Pumping per Day.	Gallons of Water Pumped per Pound of Coal.
		lbs.						
January	444.00	109,900	64,194,616	2	62,910,724	57.16	14.32	572
February	414.00	96,500	61,195,221	2	59,971,317	57.21	14.78	621
March	459.00	112,200	70,355,459	2	68,948,350	57.48	14.80	614
April	444.00	107,200	67,917,740	2	66,559,386	57.20	14.80	620
May	470.55	116,564	72,028,422	2	70,587,854	58.03	15.17	605
June	471.90	122,200	79,956,269	2	78,357,144	57.36	15.73	641
July	496.00	133,300	84,784,862	2	83,089,165	57.13	16.00	623
August	495.30	127,100	82,706,190	2	81,052,067	57.26	15.97	637
September	480.00	128,600	82,511,450	2	80,861,221	60.86	16.00	628
October	496.00	139,100	83,380,004	2	81,712,404	60.87	16.00	587
November	480.45	139,600	82,336,332	2	80,689,606	60.60	16.01	578
December	496.65	149,200	86,441,169	2	84,712,346	60.74	16.02	567
Total	5,649.45	1,481,464	917,807,734	.....	899,451,584	701.90	185.60	7,293
Averages	.....	.....	.....	.....	.....	58.49	15.47	607

Average quantity of Water Re-Pumped per Day, 2,464,250 imperial gallons.

SCHEDULE No. 5.

RECORD OF GAUGING AT ROSE HILL RESERVOIR FOR EACH MONTH OF 1893.

MONTH.	Elevation of Lowest Water above Zero.	Elevation of Highest Water above Zero.	Average Elevation above Zero.	Average Depth in Reservoir.	Average Contents in Imperial Gallons.
	ft. in.	ft. in.	ft. in.	ft. in.	
January	196 0	217 5	207 1	11 1	11,680,124
February	210 8	215 11	213 3	17 3	26,043,256
March	211 5	216 11	214 6	18 6	29,178,356
April	196 0	217 4	208 11	12 11	15,766,093
May	210 11	217 7	216 0	20 0	33,473,600
June	215 2	218 5	216 9	20 9	35,743,400
July	213 6	217 9	216 2	20 2	33,978,000
August	214 11	217 9	216 8	20 8	35,491,200
September	215 0	217 3	215 10	19 10	32,969,204
October	214 0	217 7	216 0	20 0	33,473,600
November	212 8	216 9	215 6	19 6	31,960,412
December	213 10	216 8	214 4	18 4	28,755,397
Averages	.....	...	214 2½	18 3	29,042,720

SCHEDULE No. 6.

COMPARATIVE STATEMENT SHOWING NUMBER OF GALLONS PUMPED, QUANTITY AND COST OF FUEL, ETC., FROM 1876 TO 1893.

YEAR.	Gallons of Water Pumped.	Quantity of Fuel.	Total Cost of Fuel.	Average Daily Quantity of Water Pumped.	Average Daily Consumption of Coal.	Gallons of Water Pumped per Pound of Fuel
		lbs.	$ c.	gallons.	lbs.	
1876	1,625,139,876	6,998,282	19,645 75	4,451,202	19,093	$232\frac{65}{100}$
1877	2,633,433,932	10,407,992	25,556 29	7,214,887	28,515	$253\frac{1}{100}$
1878	1,417,370,918	8,120,000	15,196 20	3,883,208	22,246	$174\frac{55}{100}$
1879	1,610,104,542	10,872,211	19,313 07	4,411,245	29,787	$148\frac{2}{100}$
1880	1,785,859,706	11,691,808	28,455 72	4,879,422	31,953	$152\frac{17}{100}$
1881	1,910,430,419	12,391,874	31,110 04	5,234,056	33,950	$154\frac{18}{100}$
1882	2,108,933,115	11,685,556	30,170 64	5,777,899	32,015	$180\frac{47}{100}$
1883	2,809,956,484	17,266,679	43,529 08	7,698,511	47,306	$162\frac{74}{100}$
1884	3,645,442,082	19,920,782	52,525 56	9,960,224	54,428	183
1885	3,537,482,598	18,644,465	46,589 27	9,691,733	51,081	$189\frac{73}{100}$
1886	4,134,376,998	19,285,371	41,979 32	11,327,060	52,837	$214\frac{37}{100}$
1887	1,417,938,169	23,283,900	50,051 85	12,103,940	63,791	$189\frac{74}{100}$
1888	1,041,964,514	20,157,935	46,600 77	11,073,875	56,049	$197\frac{56}{100}$
1889	4,148,781,634	19,231,940	44,135 10	11,366,525	52,690	$215\frac{76}{100}$
1890	5,249,760,226	24,615,830	56,239 99	14,382,901	67,536	$212\frac{26}{100}$
1891	6,207,656,403	29,300,240	60,012 77	17,007,275	80,291	$211\frac{86}{100}$
1892	6,659,925,650	34,505,875	71,805 25	18,246,371	94,278	193
1893	6,646,021,488	26,013,840	61,702 86	18,208,278	71,270	$255\frac{47}{100}$

SCHEDULE No. 7.

Quantity of Water Pumped and Amount Consumed during each Month of 1893, with Amount of Daily Consumption.

Month.	Total Quantity Pumped per Month.	Quantity Stored in Reservoir, at end of each Month.	Quantity Consumed during each Month.	Average Daily Consumption.	Total Quantity of Coal Consumed per Month at Main Pumping Station.		Average Daily Consumption of Coal.	
	gallons.	gallons.	gallons.	gallons.	tons.	lbs.	tons.	lbs.
Stored at 31st December, 1892		627,270						
January	665,355,430	31,230,200	631,752,500	20,379,112	1,105	1,395	45	690
February	513,324,474	32,461,808	515,089,866	18,396,066	1,011	1,865	36	280
March	582,771,056	33,221,402	582,014,462	18,774,660	1,269	1,840	40	1,930
April	495,019,322	17,292,166	510,978,558	17,032,618	883	1,700	29	1,256
May	570,754,313	35,995,600	552,050,879	17,808,092	1,153	1,000	37	419
June	542,027,735	34,230,200	543,793,135	18,126,437	1,062	005	35	800
July	575,774,077	34,986,800	575,017,477	18,548,950	1,135	1,655	36	1,279
August	581,077,234	33,725,800	582,338,234	18,785,104	1,096	250	35	717
September	542,556,044	31,230,300	542,051,544	18,068,384	1,036	230	34	1,074
October	541,459,638	27,909,480	547,780,458	17,670,337	1,022	770	32	1,960
November	506,627,286	30,024,272	504,512,494	16,818,083	928	180	30	1,872
December	529,244,879	30,235,751	529,033,400	17,065,593	996	950	32	288
Totals	6,646,021,488		6,616,413,007		13,006	1,840		
Averages				18,127,158			35	1,270

SCHEDULE No. 8.

Year.	Average Daily Consumption of Water.	Population.	Average Daily Consumption of Water per Capita for all Purposes.	Total Number of House Services in Use in each year.	Number of House Services Put in each year.	Total Number of Hosts in use each year.	Total Number of Meters in Use each year.	Total Number of Miles of Mains in Use each year.	Average Pressure on Pumps.			
			gallons.					miles.	No. 1, Worthington Engine.	No. 2, Worthington Engine.	No. 3, Inglis & Hunter.	No. 4, Blake Engine.
1875	3,424,000	68,678	49.86	2,769	842	.....	.....	19,810	88.10	97.51	.....	.....
1876	4,451,202	71,693	62.09	3,512	740	.....	.....	80,230	88.78	97.69	.....	.....
1877	2,812,000	67,386	41.74	4,518	1,006	.....	.....	107,570	83.33	97.69	.....	.....
1878	3,883,208	70,867	51.79	6,707	2,189	28	.....	110,240	89.65	96.64	.....	.....
1879	4,411,245	73,813	59.76	8,568	1,861	47	.....	111,293	95.25	99.04	.....	.....
1880	4,879,422	75,110	64.96	9,582	1,014	66	.....	113,312	98.22	99.52	.....	.....
1881	5,231,056	76,931	68.03	12,236	2,654	79	.....	115,518	96.32	100.78	.....	.....
1882	5,777,809	81,372	71.01	14,062	1,826	94	.....	116,145	94.85	101.66	.....	.....
1883	7,638,511	91,796	83.87	16,276	(1,786) (448)	100	.....	131,352	94.27	106.49	.....	.....
1884	9,960,224	105,211	94.66	18,363	2,087	130	.....	138,301	99.146	107.036	.....	.....
1885	9,706,127	111,800	86.82	20,707	2,314	140	195	143,257	98.84	106.45	103.85	.....
1886	11,344,337	118,403	95.81	23,043	2,936	152	256	151,012	104.85	104.92	104.67	.....
1887	12,030,640	126,169	95.59	26,883	3,315	176	332	165,801	.....	.....	.....	.....
1888	11,069,784	166,809	66.36	29,883	3,055	174	897	182,625	93.41	92.36	94.37	.....
1889	11,378,962	175,000	65.02	34,056	3,288	222	1,347	212,832	94.25	94.82	94.92	.....
1890	14,434,732	185,000	78.02	36,192	2,191	250	1,479	226,267	92.83	93.65	93.38	.....
1891	17,007,275	188,904	90.03	38,250	2,111	230	1,644	237,967	93.33	93.66	93.91	.....
1892	18,246,371	188,904	96.59	39,401	1,200	258	1,635	242,743	.....	.....	.....	.....
1893	18,208,278	188,904	102.22	39,927	526	300	1,990	244,961	94.18	91.18	94.18	96.37

SCHEDULE No. 9.

COMPARATIVE STATEMENT OF COAL CONSUMED AND WATER PUMPED. 13-14

MONTH.	1892.			1893.				
	Water.	Coal.		Engine.	Water.		Coal.	
	Quantity Pumped.	Quantity Consumed.			Quantity Pumped.	Total.	Quantity Consumed.	Total.
	imp. gals. net.	tons.	lbs.		imp. gals. net.	gallons.	tons. lbs.	tons. lbs.
January	555,634,839	1,400	700	Nos. 1, 2, and 3	536,629,710		1,210 50	
				" 4	128,725,720		195 1,345	
						665,355,430		1,405 1,395
February	536,175,961	1,377	450	" 1, 2, and 3	245,887,421		688 290	
				" 4	267,437,053		323 1,575	
						513,324,474		1,011 1,865
March	580,631,212	1,570	1,100	" 1, 2, and 3	307,414,536		884 1,950	
				" 4	275,356,520		384 1,890	
						582,771,056		1,269 1,840
April	536,374,567	1,486	975	" 1, 2, and 3	203,411,152		627 960	
				" 4	291,638,170		261 740	
						495,049,322		888 1,700
May	534,289,868	1,411	1,810	" 1, 2, and 3	247,193,240		740 1,530	
				" 4	323,561,073		412 1,470	
						570,754,313		1,153 1,000
June	556,006,988	1,384	280	" 1, 2, and 3	254,061,771		702 1,505	
				" 4	287,965,964		359 500	
						542,027,735		1,062 5
July	568,828,241	1,408	1,885	" 1, 2, and 3	267,285,198		760 200	
				" 4	308,488,879		375 1,455	
						575,774,077		1,135 1,655
August	592,307,937	1,490	460	" 1, 2, and 3	262,930,695		737 1,870	
				" 4	318,146,539		358 380	
						581,077,234		1,096 250
September	572,137,995	1,465	510	" 1, 2, and 3	240,180,552		660 1,515	
				" 4	302,375,492		375 715	
						542,556,044		1,036 230
October	527,221,195	1,525	85	" 1, 2, and 3	256,020,593		669 915	
				" 4	285,439,045		352 1,855	
						541,459,638		1,022 770
November	514,377,567	1,289	290	" 1, 2, and 3	225,427,012		573 230	
				" 4	281,200,274		354 1,950	
						506,627,286		928 180
December	585,939,280	1,440	1,330	" 1, 2, and 3	229,051,972		601 320	
				" 4	300,192,907		395 630	
						529,244,879		996 950
Totals	6,659,925,650	17,252	1,875			6,646,021,488		13,006 1,840
Averages								

Average quantity of Water Pumped per Day, 1893 . . . 18,208,278 imperial gallons.

" " pound of Coal . 255.479 "

SCHEDULE No. 10.

COMPARATIVE STATEMENT OF PUMPING 1,000 GALLONS OF WATER.

YEAR.	Cost of Maintenance, Main Pumping Station.	Gallons Pumped.	Cost of Maintenance per 1,000 gals.	Cost of Fuel alone per 1,000 gals.	Total Cost of Pumping 1,000 gals
	$ c.		c.	c.	c.
1885	65,082 39	3,536,482,598	1.840	1.317	7.240
1886	65,579 74	4,134,376,998	1.586	1.015	6.561
1887	76,597 16	4,417,938,169	1.734	1.132	6.643
1888	76,059 72	4,041,964,514	1.880	1.126	7.591
1889	75,360 77	4,148,781,636	1.816	1.063	8.259
1890	83,136 12	5,249,760,226	1 583	1 038	7.764
1891	89,060 35	6,534,375,161	1.362	0.901	6.261
1892	103,202 91	6,659,925,650	1.549	1.078	6.048
1893	109,582 56	6,646,021,488	1.648	0.973	

MEMO.—The cost of maintenance of Main Pumping Station in 1893 includes items of extraordinary expenditure, as follows: Eno Steam Generator, $2,125, thoroughly overhauling, and repairing the old engines, Nos. 1, 2, and 3, $7,250.33, and amount paid in settlement of Messrs. Polson & Co.'s account for steel tank, $1,500, making a total of $10,875.33. Eliminating the above-mentioned special items, and taking the same comparative basis of calculation as in preceding years, the cost of ordinary maintenance would be $98,707.23, and the cost of maintenance per 1,000 gallons would be $01.485.

SCHEDULE No. 11

COMPARATIVE STATEMENT OF WATER PUMPED PER POUND OF COAL.

MONTH.	1889.	1890.	1891.	1892. 5 Slip.	1893.
	gallons.	gallons.	gallons.	gallons.	gallons.
January	213	225	226	209	236
February	204	221	212	205	253
March	208	218	233	195	229
April	218	221	225	190	278
May	209	217	221	199	247
June	214	208	212	212	255
July	212	217	219	215	253
August	208	202	219	209	265
September	231	213	229	206	261
October	220	210	226	182	264
November	218	211	223	210	272
December	231	205	219	214	265
Average	215	214	222	203*	256

* If 10% slip allowed, 193 gallons.

SCHEDULE No. 12.

Total List of All Mains Laid During 1893.

(For Mains laid previous to 1893, see Reports of 1890, 1891 and 1892.)

Name of Street, Avenue, Etc.	Side of Street.	Location.	No. of Feet.
36-in. Pumping Main.			
Across G.T.R.R. tracks	Espl'nade	From valves to foot of bank on Front Street.	370
12-in. Sub-Mains.			
Carlton	North	From Sherbourne to Parliament	1,470
"	"	" Parliament St. to Sumach	1,504
Gerrard	"	" Leslie St. to Logan Ave.	3,467½
Parliament	East	Connecting jog in Carlton St	121
Queen West	South	At intersection of York St.	108¼
York	East	From Front to King	928
"	West	" King to Queen	1,221¼
High Level Station			220
		Total	9,060
6-in. Mains.			
Bain Ave	North	From Logan Ave. east to old hydrant	328
Blair Ave	"	" Dovercourt Rd. to Abel St.	525
Cecil	"	" Beverley St. west to old main	198¾
Church	West	" Wilton Ave. to Gerrard St.	1,080
College	North	" McCaul St. to Huron	1,230
Commercial	"	" Francis St. west to end	184
Exhibition Gr'nds		" opp. D'g Pens to rear of Grand Stand.	451½
"		" " Pond " "	608¾
Galt Ave.	West	" Gerrard St. north	40
Glen Rd	"	" Maple Ave. north to old main	190
Centre Rd.	East	" Roxborough Ave. to North Drive	385½
Harbord	South	" Bathurst St. west	256½
Indian Rd	East	" Lake Shore Rd. north	329
Lake Shore Rd	South	" old hydrant opp. P.C.B. H. to Indian Rd	562
Logan Ave	West	" Withrow Ave. to Bain Ave.	371
Mansfield Ave	South	" Grace St. east to old main	169½
Maple Ave	"	" Glen Rd. to (jog in) Glen Rd.	188¼
North Drive	North	" Rosedale Rd. to (jog in) Rosedale Rd.	367
Olive Ave.	"	" Palmerston Ave. to connect	53
Preston Ave	East	" south to north of Hallam St.	188½
Queen East	South	" Yonge to Victoria	247
"	"	" Jarvis to Sherbourne, west side	974
"	"	" east side Sherbourne to Power St.	1,592

MAINS LAID DURING 1893—*Continued.*

NAME OF STREET, AVENUE, ETC.	Side of Street.	LOCATION	No. of Feet.
6-IN. MAINS—*Con*			
Main Pumping Station		Through and on north side new boiler-house.	83½
Rosedale Rd	East	From North Drive south to old main	254
Ruskin Ave.	North	" Perth Ave. west	158½
St. Vincent	East	" Grenville to Grosvenor	294½
"	"	" Grosvenor to St. Joseph	1,201½
Sherbourne	"	" Elm Ave. south to hydrant	184
Walmer Rd	West	" north side St. Bernard south	257
West Lodge Ave.	"	" Queen to Convent fence	286
Woodbine Ave.	East	" Queen St. East south	1,184
Yonge	West	" Wickson Ave. to Walker Ave	263
		Total	14,685

MAINS TAKEN UP AND ABANDONED DURING 1892.

STREET.	LOCATION.	No. of Feet.
8-IN. OLD IRON.		
York	King to Queen	1,228
Queen West	Intersection of York St	108
Queen East	Yonge to Victoria	247
	Total	1,583
12-IN. CEMENT.		
College	McCaul to Huron St	1,230
St. Vincent	Grenville to St. Joseph St	1,500
	Total	2,730
6-IN. CEMENT.		
Church	Wilton Ave. to Gerrard St	1,980
Queen	Jarvis to Sherbourne St	974
"	Sherbourne to Power St	1,568
	Total	3,622
6-IN. IRON.		
Parliament	From s. of Carlton to n. of Carlton St. jog	110
Rosedale Rd	" opp. the curve now closed up	350
	Total	460
4-IN. IRON.		
Yonge	From Wickson to Walker Ave	263

Summary of Mains.

Mains throughout the City of all Sizes and Descriptions, including those on Streets, Government, Private and other Property, at end of 1895.

Size.	Length in Feet.
36-inch Mains	2,664
30 " "	10,023
24 " "	24,397
20 " "	3,953
12 " Sub-Mains	223,611
10 " "	13,320
8 " "	7,922
6 " "	931,485½
4 " "	38,632
3 " "	10,203¼
2 " "	831½
1 " "	3,162
Old Iron Mains	13,470
Cement Mains	9,680
Total length in feet	1,293,410¾
" miles	244.964

Table Showing Location and Description of Old Mains of the Furness System still in Use.

Location.	Description.	No. of Feet.	Totals.
On John St., from Queen and along	12 in. Cement	840	
" Grange Rd. to Beverley St.	"	250	
" Beverley St., from Grange Rd. to St. Patrick	"	750	
" St. Patrick west to Beverley	"	480	
			2,320
" Gerrard St., from Yonge to Jarvis	8-in. Iron	1,660	
" John St., from King to Queen	"	1,240	
" Jarvis St., from King to Queen	"	1,150	
" Peter St., from Queen to Front St	"	2,180	
" Queen St., from Victoria to Jarvis St	"	1,200	
" Queen St., from Yonge to York	"	1,500	
" Queen St., from York to Peter	"	2,250	
			11,180
" Adelaide St., Yonge to Victoria	6-in. Iron	340	
" Berkeley St., from King to Front	"	300	
" King St. West, from Simcoe to Peter	"	1,650	
			2,290
" King St. West, from Bathurst to Peter	6-in. Cement	2,750	
" McCaul St., from Caer-Howell to College	"	1,300	
" Caer-Howell, from McCaul to College St	"	560	
" Queen St. West, from Bathurst to Peter	"	2,750	
			7,360
Total			23,150

SCHEDULE No. 13.

Hydrants Placed in Position during 1893.

(For Hydrants placed in position previous to 1893, see Reports for 1890, 1891 and 1892.)

Name of Street, Ave., Etc.	Side of Street.	Location.
Berkeley	West	7 feet south of Queen St. East.
Blair Ave	North	238 " west of Dovercourt Rd.
Carlton	"	85 " east of Sherbourne St.
"	"	141 " " Bleeker St.
"	"	12½ " west of Ontario St.
"	"	259½ " east of Ontario St.
"	"	121⅜ " west of Parliament St.
"	"	172½ " east of Parliament St.
"	"	161 " " Metcalf St.
"	"	138¾ " " Sackville St.
"	"	125½ " " Maple Pl.
Church	West	204½ " north of Wilton Ave.
"	"	143½ " south of Gould Street.
"	"	211 " " Gerrard St.
"	"	167 " north of Gould Street.
College	North	Opposite McCaul St.
"	"	7 feet east of St. George St.
"	"	153¾ " " Huron Street.
Commercial	"	6 " " Francis St.
"	"	146½ " west of Francis St.
Elizabeth	East	At north-east corner of Hagarman St.
Exhibition Grounds	...	In rear of Grand Stand.
"	...	179 feet north of Grand Stand.
"	...	370 " " "
"	...	In rear of "
"	...	115½ feet north of "
"	...	326 " " "
Centre Rd	East	30 " " North Drive.
Galt Ave.	West	14 " " Gerrard St.
Gerrard	North	304 " west of Leslie St.
"	"	386 " " Galt Ave.
"	"	243½ " east of Pape Ave.
"	"	207¾ " west of Pape Ave.
"	"	In north-east corner of Subway.
"	"	75 feet west of Carlaw Ave.
"	"	245½ " east of Logan Ave.
York	East	45 " north of Front St.
"	"	131 " " Piper St.
"	"	68½ " " Wellington St.
"	"	119½ " " Millstone Lane.
"	West	34 " south of Pearl St.
"	"	86 " north of Pearl St.
"	"	135¼ " " Adelajde St.

HYDRANTS PLACED IN POSITION DURING 1893 *Continued.*

NAME OF STREET, AVE., ETC.	Side of Street.	LOCATION.
York	West	98 feet south of Richmond St.
"	"	122¾ " north of Richmond St.
"	"	At north-west corner of King St. (refixed).
Main Pumping Station.	North	North side of new boiler-house.
Indian Rd	East	154 feet north of G T R.R. tracks.
James	"	146 " " Queen West.
John	West	170 " " King St.
Lake Shore Rd	North	105 " east of Indian Rd.
Logan Ave	West	237 " north of Withrow Ave.
North Drive	North	At north-east cor. of Rosedale Rd. (to north).
"	"	Opposite Rosedale Rd. (to south).
High Park Rd	South	157 feet west of Indian Rd.
"	"	504 " " "
"	"	929 " " "
Preston Ave	East	75½ " south of Hallam St.
Poulett Ave.	West	At south end of street.
Queen East	South	11 feet east of George St. (renewed same place).
St. Vincent	East	273 feet north of Grenville St.
"	"	148½ " " Grosvenor St.
"	"	At south-east corner St. Alban's St.
"	"	194 feet north of St. Alban's St.
Sherbourne	"	145½ " south of Maple Ave.
Sumach	"	At north-east corner of Blevins St.
West Lodge Ave.	West	At north end 218½ feet north of Queen St.
Woodbine Ave	East	221 feet south of Queen St. East.
"	"	519½ " " "
"	"	816½ " " "
"	"	1068½ " " "

SUMMARY OF HYDRANTS.

Number of Hydrants set on streets at end of 1892	2,709
" " private and other property at end of 1892	59
	2,768
In renewing, etc., Mains there were taken off the streets in 1893	10
	2,758
Number of Hydrants additional set on streets during 1893	63
" " " private and other property, 1893	6
Total number of Hydrants in use at end of 1893	2,827

List of Hydrants Removed off Streets during 1893.

Name of Street, Etc.	Side of Street.	Location.
Church	West	278 feet north of Wilton Ave.
"	"	273 feet north of Gould St.
College	North	At north-east corner St. George St., Y.W.W.
Queen East	South	At south-east corner Berkeley St.
Rosedale Rd.	East	At junction of North Drive, s. e. cor., Y.W.W.
St. Vincent	West	At north-west corner of Grosvenor St.
"	"	At south-west corner of St. Albans St.
Victoria	"	Half-way between King and Adelaide.
Yonge	East	At north-east corner Alexander St.
York	West	192 feet south of Richmond St.

SCHEDULE No. 14.

TOTAL LIST OF ALL VALVES PLACED IN POSITION DURING 1893, SHOWING THE SIZE, POSITION, ETC.

(For Valves placed in position previous to 1893, see Reports of 1890, 1891 and 1892.)

NAME OF STREET, AVE., ETC.	Side of Street.	LOCATION.
12-IN. STOP VALVES.		
Carlton	North	East line of Sherbourne St.
"	"	West " Ontario St.
"	"	" " Parliament St.
"	"	East " Parliament St.
"	"	West " Sackville St.
"	"	" " Sumach St.
Dundas	"	East " Rusholme Rd.
Front	"	" " Church St.
Gerrard	"	West " Leslie St.
"	"	" " Galt Ave.
"	"	East " Pape Ave.
"	"	West " Pape Ave.
"	"	East " Logan Ave.
High Level Station	.....	In front of Engineer's residence.
Queen	South	West line of York St.
York	East	North " Front St.
"	"	South " Wellington St.
"	"	North " Wellington St.
"	"	South " King St.
"	West	North " King St.
"	"	South " Adelaide St.
"	"	North " Adelaide St.
"	"	South " Queen St.
King	North	West " Armour St.
"	"	Opposite centre of Mercer Reformatory.
9-IN. STOP VALVES.		
Queen West	South	East line of York St.
"	"	" " John St.
6-IN. STOP VALVES.		
Bain Ave	North	East line of Logan Ave.
Blair Ave.	"	" " Abel St.
"	"	West " Dovercourt Rd.
Carlton	South	" " Ontario St.
"	"	" " Sackville St.
Cecil	North	" " Beverley St.
Church	West	North " Gould St.

TOTAL LIST OF ALL VALVES PLACED IN POSITION DURING 1893 *Continued.*

NAME OF STREET, AVE., ETC.	Side of Street.	LOCATION.
6-IN. STOP VALVES—*Con.*		
College	North	East line of St. George St.
Centre Rd	East	South " Roxborough St.
"	"	North " North Drive.
Dunbar Rd.	West	South " Hill St.
Elm Ave	North	West " Glen Rd.
Galt Ave	West	North " Gerrard St.
Glen Rd	"	" " Maple Ave.
"	East	" " Dale Ave.
Gladstone Ave.	West	South " Trafalgar Ave.
Harbord	South	West " Bathurst St.
Howland Ave.	West	North " Wells St.
"	"	South " Wells St.
Indian Rd	East	North " Lake Shore Rd.
Mansfield Ave.	South	East " Grace St.
Maple Ave.	"	" " Glen Rd.
North Drive	North	" " Woodland Ave.
"	"	" " Rosedale Rd.
Olive Ave.	"	" " Palmerston Ave.
Ontario	West	North " Carlton St.
Preston Ave.	East	" " Hallam St.
Park Rd	North-west	At Junction of Park Rd. and Gwynne St.
Pearl	North	East line of York St.
"	"	West " York St.
Pape Ave.	West	North " Gerrard St.
Piper's Lane	South	East " York St.
Queen East.	"	" " George St.
"	"	" " Ontario St.
"	"	West " Parliament St.
Queen West	"	" " Dovercourt Rd.
Richmond	North	East " York St.
"	"	West " York St.
Rosedale Rd	East	South " Roxborough St.
"	"	" " North Drive.
Ruskin Ave.	North	West " Perth Ave.
Sackville	East	North " Carlton St.
Sherbourne	"	South " Maple Ave.
St. Vincent	"	South " Grosvenor St.
"	"	North " Grosvenor St.
West Lodge Ave.	West	North " Queen St., W.
Woodbine Ave.	East	South " Queen St., E.
Maple Ave	West	North " Carlton St.
8-IN. STOP VALVE.		
Queen East	South	West line of Church St.

VALVES TAKEN OUT DURING THE YEAR 1893.

NAME OF STREET, AVE, ETC.	Side of Street.	LOCATION.
36-IN. STOP VALVE.		
Esplanade		On 36-in. pumping main north of 30-in. connection from No. 4.
8-IN. STOP VALVES.		
York	West	North line of King St.
"	"	South " Adelaide St.
"	"	North " Adelaide St.
"	"	South " Queen St.
6-IN. STOP VALVES.		
Rosedale Rd.	East	At intersection of Road now closed.
St. Vincent	"	South line of Breadalbane St.
Simcoe	"	North " Esplanade St.
6-IN. CHECK VALVES.		
Breadalbane	South	West line of Yonge St.
Irwin Ave	North	" " Yonge St.
St. Alban's	South	" " Yonge St.
St Joseph's	"	" " Yonge St.
St. Mary's	"	" " Yonge St.

Summary of Valves on Streets.

Size	In use at End of 18 2.	Put in During 1893.	Taken out During 1893.	Total at End of 1893.
Stop Valves.				
36 Inches	5		1	4
30 "	8			8
24 "	16			16
20 "	2			2
12 "	358	25		383
10 "	9			9
9 "	11	2		13
8 "	11	1	4	8
6 "	1430	48	3	1475
4 "	46			46
3 "	24			24
Total.	1920	76	8	1988
Check Valves.				
36 Inches.	2			2
30 "	1			1
24 "	1			1
20 "	1			1
12 "	12			12
6 "	50		5	45
Total.	67		5	62

SCHEDULE No. 15.

Statement of House Services Laid in 1893.

Name of Street.	Size of Service.							
	½-in.	⅝-in.	¾-in.	1-in.	2-in.	3-in.	4-in.	6-in.
Abell	1							
Ann	2							
Agnes	6							
Alice	2							
Albert	1							
Avenue lane	1							
Avenue road	1							
Austin avenue	2							
Alexander	1							
Admiral road	2	1						
Adelaide, west	1							
Bathurst	6							
Brunswick avenue	5							
Booth avenue	3							
Brooklyn	4							
Bismarck avenue	1							
Barton avenue	3							
Baldwin	1							
Bellair	2							
Brock avenue	2							
Blair	1			1				
Borden	4							
Burnfield avenue	1							
Berkley			1					
Bloor, west	1							
Bloor, east	1							
Broadview avenue	1							
Bain avenue	1							
Beatty avenue	1							
Brookfield	1							
Bellwood's avenue	1							
Boswell avenue	2							
Buchanan	1							
Bay		1						
Beverley			1					
Carr	2							
Clinton lane	1							
Crescent road				1				
Chestnut	1							
Carlton	2							
Colborne	1				1			
Cottingham	1							
College avenue	4			1			1	
Clifford	1							

HOUSE SERVICES LAID IN 1893—*Continued.*

NAME OF STREET.	SIZE OF SERVICE.							
	½-in.	⅝-in.	¾-in.	1-in.	2-in.	3-in.	4-in.	6-in.
Castle Frank avenue			1					
Commercial	1							
Carlaw avenue	1							
Close avenue	8							
Concord avenue	2			1				
Campbell	1							
Christie	1							
Crawford	4							
Crocker avenue	1							
Cowan avenue	11							
Church	8							
Dalhousie	2							
Delaware avenue	6							
Dunbar road		1						
Dunn avenue					1			
Dundas	7							
Dufferin	7							
Davenport Road	7							
Denison avenue	4							
D'Arcy	7							
Dupont	1							
Edmund avenue	1							
Esplanade, east	1						1	
Elizabeth	4							
Elm	1							
Edwin avenue	2							
Eastern avenue	*2							
Euclid avenue	9							
Farley avenue	6							
Front, east	6			1	1			
Front, west	1							
Franklyn avenue	1							
Fermanagh avenue	1							
Fenning	1							
Galt avenue	7							
Gerrard, east	1							
George	2							
Grosvenor	1							
Glen road	2							
Gwynne avenue	2			1				
Grand avenue	2							
Garden avenue	1							
Givens	2							
Hallam avenue	1							
Hamburg avenue	2							
Hayter	2							
Harbord	4							

House Services Laid in 1893—*Continued.*

Name of Street.	Size of Service.							
	½-in.	⅝-in.	¾-in.	1-in.	2-in.	3-in.	4-in.	6-in.
Hawthorne	2							
Huron	2							
Ivy avenue	1							
Indian road	1			1				
Jamieson avenue	3							
Jones	4							
Jarvis	3							
James								1
King, east	2							
King, west	12		1		1		1	
Lamport avenue			1					
Leslie	1							
Logan avenue	1							
Lewis	1							
Louisa	1							
Lippincott	2							
Lansdowne	1							
Markham	13							
Manning	11							
Milan	4							
Macdonell avenue	2							
Marion	1							
Melbourne avenue	5							
Mill	1	1						
Madison avenue	8							
MacPherson avenue	9							
McGill	3	1						
McGee	2							
Morse	5							
Mark	1							
Millstone lane	1							
Murray					1			
Matilda	1							
McMurrich	4							
Marlborough avenue	5							
Mackenzie avenue				1				
Montague place	1							
Norfolk	2							
Noble	2							
Niagara	3							
Nelson	1							
North drive	1							
Ontario	2							
Oak	3							
Orde					1			
Pape avenue	2							

House Services Laid in 1893—*Continued.*

Name of Street.	Size of Service.							
	½-in.	⅝-in.	¾-in.	1-in.	2-in.	3-in.	4-in.	6-in.
Parliament	2							
Pearson	1							
Palmerston avenue	3							
Preston avenue	1							
Portland	2							
Phœbe	1							
Pears avenue	3							
Power	1							
Pearl				1				
Queen, west	13	2		1				
Queen, east	4							
Regent	1							
River	3							
Reid	2							
Ruskin	1							
Richmond, west	1		1				3	
Robert place	1							
Rosedale road			1					
Rusholme road	1							
Roseberry avenue	2							
Spencer avenue	8							
Springhurst	4							
Spadina road	3	2						
St. George		2	1					
Sumach	5			1				
Seaton	1			1				
Sherbourne		2		2				
Sydenham	1							
St. Enoch's square	1							
Smith	1							
Scollard	5							
Shuter	1							
Simcoe	1			1			2	
Salem	1							
Sully	2							
Symington avenue	1							
Sheridan avenue	1							
Shannon	1							
Shaw	3							
St. Paul	1							
Shanley avenue	2							
St. Helen's avenue	2							
Tate	2							
Tyndall avenue	1							
Trinity		1						
Tranby avenue		1						
Victoria			1					

HOUSE SERVICES LAID IN 1893—*Continued.*

NAME OF STREET.	SIZE OF SERVICE.							
	½-in.	⅝-in.	¾-in.	1-in.	2-in.	3-in.	4-in.	6-in.
Walmer road	6		1					
Wilson ave	4							
Wyndham	1							
Wallace avenue	1							
William avenue	2							
Woodland avenue			1					
Wascana avenue	1							
Wickson avenue	1							
Wellesley Crescent			1					
Wellesley place		1						
Wellesly	2	1						
Wellington, west		1			2			
Woodbine avenue	3							
Wardell	2							
Yonge			1					
Yorkville	1							
Total	465	18	13	15	8		8	1

STATEMENT OF HOUSE SERVICES IN USE 31ST DECEMBER, 1813.

Total number of services in use previous to 1874	1,375
" " laid during 1874	552
Number of new " " 1875	842
" renewed " " 1875	24
" new " " 1876 (by permit)	141
" renewed " " 1876 "	12
" new " laid by Commission 1876	602
" renewed " " " 1876	258
" new " " " 1877	1,006
" renewed " " " 1877	161
" new " " Corporation 1878	2,189
" renewed " " " 1878	103
" new " " " 1879	1,861
" renewed " " " 1879	97
" new " " " 1880	1,014
" renewed " " " 1880	41
" new " " " 1881	2,654
" renewed " " " 1881	117
" new " " " 1882	1,826
" renewed " " " 1882	44
" new " " " 1883	1,766
" renewed " " " 1883	54
" new " " " 1884	2,087
" renewed " " " 1884	12
" new " " " 1885	2,344
" renewed " " " 1885	22
" new " " " 1886	2,936
" renewed " " " 1886	19
" new " " " 1887	3,250
" renewed " " " 1887	65
" new " " " 1888	2,990
" renewed " " " 1888	65
" new " " " 1889	3,288
" renewed " " " 1889	68
" new " " " 1890	2,136
" renewed " " " 1890	55
" new " " " 1891	2,058
" renewed " " " 1891	53
" new " " " 1892	1,151
" renewed " " " 1892	49
" new " " " 1893	526
" renewed " " " 1893	2
New services in Yorkville at time of annexation	448
" Parkdale " "	885
	41,248
Less number of renewed services	1,321
Total services in use	39,927

	¼ in.	⅜-in.	½-in.	⅝-in.	¾-in.	1-in.	1½ in.	2-in.	2½ in.	3-in.	4-in.	6-in.	Total.
Services laid previous to 1875*	...	.....	.....	.....	.....	.....	..	.....	..	.. ..	.....	.....	1,927
New services laid 1875	...	.....	617	194	38	7	4	5	....	1	.....	.....	866
" " 1876	....	.....	900	80	11	8	1	4	1	8	.....	...	1,013
" " 1877	...	.....	1,083	43	9	8	....	10	....	14	...	....	1,167
" " 1878	86	1,427	717	28	5	9	....	5	...	14	1	....	2,292
" " 1879	....	1,248	633	47	9	5	....	4	....	12	..	....	1,958
" " 1880	....	607	385	26	7	3	..	8	....	19	....	....	1,055
" " 1881	....	1,375	1,275	62	17	17	....	7	....	17	1	..	2,771
" " 1882	..	625	1,139	44	23	20	....	5	....	14	....	....	1,870
" " 1883	....	373	1,311	70	16	13	....	17	....	17	3	....	1,820
" " 1884	...	441	1,519	70	13	25	....	9	....	20	2	....	2,099
" " 1885	...	190	2,068	56	26	13	....	7	....	5	....	1	2,366
" " 1886	....	14	2,741	92	37	29	....	9	....	25	...	8	2,955
" " 1887	....	10	3,062	106	55	38	....	15	....	25	....	4	3,315
" " 1888	....	.....	2,856	101	32	22	....	19	....	14	7	4	3,055
" " 1889	....	.....	3,087	127	52	45	....	19	....	1	24	1	3,356
" " 1890	....	.....	1,995	83	37	35	....	16	....	.....	24	1	2,191
" " 1891	....	.....	1,995	33	34	24	....	11	....	.....	13	1	2,111
" " 1892	....	.....	1,109	26	23	23	....	7	....	.....	12	....	1,200
" " 1893	...	.....	465	18	13	15	...	8	...	.....	8	1	528
	86	6,310	28,957	1,306	457	359	5	185	1	206	95	21	39,915
Laid by Yorkville previous to annexation*	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.. .	448
Laid by Parkdale previous to annexation*	....	.....	.....	....	.....	.....	.....	.....	...	.....	.....	....	885
													41,248

* No record of sizes.

APPENDIX "C."

CITY ENGINEER'S REPORT

UPON

Proposed Enlargement and Improvement in Toronto Water Works System.

CITY ENGINEER'S REPORT UPON PROPOSED ENLARGEMENT AND IMPROVEMENT IN TORONTO WATER WORKS SYSTEM.

CITY ENGINEER'S OFFICE,
Toronto, October 30th, 189-.

To the Chairman and Members of the Committee on Works:

GENTLEMEN,—On the 30th January last, the Water Works Committee was abolished, and the management of the works was transferred to this Department.

The Minute of Council bearing upon this subject contains, among other things, the following instructions:

"It is further recommended that the City Engineer be instructed to make a thorough inspection of the Water Works system and machinery, and report at the earliest moment needed additions, alterations, etc., and the cost thereof, or any portion thereof, as he may deem necessary, for the purpose of placing the amount in the Estimates for the year."

At the time these instructions were issued, the affairs of the Water Works Department were known to be in a bad condition. The conduit, which was intended to convey the water from Lake Ontario to the Main Pumping Station, had only a few weeks previously met with a disastrous accident. Long sections had risen to the surface and broken in several places, while portions still remained projecting above and imbedded in the ice in Blockhouse Bay and Toronto Harbor. The lake water being thus cut off, the entire water supply of the City was being drawn directly from the sewage polluted harbor, and as a natural consequence sickness was prevalent throughout the City, typhoid fever threatened to become epidemic, and a general state of alarm and uneasiness existed among the citizens.

Under these circumstances, I considered my first and most imperative duty was to devote special attention to repairing and replacing the damaged conduit and to search out the weakest and most dangerous points in the system, with the view to effecting a remedy and restoring confidence in the safety of the water supply for ordinary use, if possible. This, I think, has now been partially accomplished, and it is my only excuse for the delay which has occurred in presenting this report.

I have already made several reports and recommendations, the carrying into effect of which will be to increase the pumping capacity and to improve the character of the works; but as most of these recommendations have already been adopted and funds provided, it is unnecessary that I should refer to them here.

I find, however, that the impression appears to be general among the Aldermen that I am expected to enquire into and report upon the whole question of our future water supply.

The only instructions I have on this subject are contained in a resolution of Council passed on the 13th February last, of which the following is a copy, viz.:

"Ald. Davies moves that the City Engineer, while considering the question of our future water supply, be instructed to report as to the advisability of securing a pure supply of water by gravitation from Scarboro' Heights, and also as to the cost of removing the pumping plant to the lake front at that point, with the necessary mains to connect with the present system."

The consideration of the question of the future water supply of the City involves a study of the various projects which have at different times been brought forward, each of which has its advocates and most of which have recently been discussed to some extent either in the papers or at public meetings.

Two or three offers, I understand, have been made by different persons or syndicates to supply water to the City for a stipulated price per 1,000 gallons, delivered either into the existing mains, at some defined point, or into Rose Hill Reservoir, or a new reservoir to be hereafter constructed; but I have no positive or official knowledge regarding the details of these proposals, as they were not submitted to me.

I may, however, say with regard to all proposals of this kind, that in my opinion, the public interests demand that the control of the entire water supply of the City, in all its bearings and details, should be vested in, retained and jealously guarded by the municipal authorities.

The following is a list of the various schemes proposed, so far as they have have come under my notice:

1. From Lake Ontario, in the vicinity of Scarboro'.
2. From Lake Ontario, in the vicinity of Mimico.
3. From the Oak Ridge Lakes and the Rivers Don and Rouge (by gravity).
4. From Lake Simcoe.
5. From wells sunk in the gravel beds north of the City.
6. From springs and artesian wells in the Township of Erin.
7. From the vicinity of the present intake.

In order to dispose of the matter, as far as I am concerned, I propose briefly to refer to each of these projects, which I will take *seriatim*:

1.—From Lake Ontario, in the Vicinity of Scarboro'.

This scheme would involve laying at least one new large main about 6½ miles in length to connect with the existing system; the construction of new wharves and buildings at Scarboro'; moving the present high duty pumping plant to that point, and probably the erection of an additional ten-million gallon

engine, besides involving a new and large intake pipe or conduit, which would require to be over two miles in length, if it is desired to draw the water from the same depth as the present intake, which is seventy-five feet below the surface. In preparing the estimate, however, I have provided for the intake to be placed at a depth of only sixty feet, which would probably be sufficient. By this means the lake conduit could be shortened to 9,000 feet. At present prices, $1,000,000 is a moderate estimate for completing this scheme on the above basis, so as simply to connect with the existing system and allowing for the new main to be forty two inches in diameter, which is as small as it should be.

If a hundred-million gallon reservoir at Scarboro' is to be added—as apparently required under Ald. Davies' resolution—in order "to obtain a supply by gravity from that point," the above estimate would have to be very largely increased. The amount of this increase I am not at present in a position to state, because I am not in possession of sufficient information regarding the topography of the country, the most suitable site for the reservoir, and the character of the sub-soil, to warrant my making any estimate. It was my intention to have these matters thoroughly looked into, but the appropriation at my disposal was not sufficient to cover the cost of the investigation necessary. I may say, however, that Messrs. Hering & Gray, who in 1889 investigated and reported upon a scheme for obtaining the water supply from the vicinity of Victoria Park, estimated the cost of a hundred-million gallon reservoir on Wells' Hill (with the necessary connections) at $305,000, and it is not likely that a similar reservoir at Scarboro' would cost less

Under existing conditions I do not think it advisable to draw the water supply of the City from the vicinity of Scarboro' or Victoria Park for the following chief reasons, viz.:

1. The exposed position and unsuitable character of the shore for the establishment of a pumping station and wharves.

2. The great length to which it would be necessary to lay the suction pipe or conduit in the lake, in order to reach a suitable depth.

3. The turbid character of the water in the Spring, which is reported on good authority to extend southwardly into the lake two miles.

4. The risk and uncertainty of being able to construct a tight reservoir, within a reasonable cost, in the sandy and gravelly soil on the heights in that vicinity, in the event of such a reservoir being needed.

I might also remark that this scheme, if adopted, would not be likely to prove satisfactory unless a new reservoir, having a capacity of at least one hundred million gallons, is constructed at Wells' Hill, or somewhere in that neighborhood, and that there does not at present seem to be any great advantage to be gained by pumping the water into a reservoir at Scarboro'.

II.—From Lake Ontario, in the Vicinity of Mimico.

I am not aware of this scheme ever having been thoroughly investigated and recommended by any water works engineer.

My investigations have been confined to a partial inspection of the shore and lake in the early Spring and a drive over the country along or near the probable route of the rising main.

The prospect did not appear sufficiently inviting to justify much further attention to this project. The water for a long distance from the shore (probably from two to three miles) appeared to be riled and dirty. From this I should infer that the shallow water extends out quite as far, if not further, than off Scarboro', and that the lake conduit would consequently have to be a very long one. The length of main required would be considerably greater than the main from Scarboro'; a new and large reservoir at or about Wells' Hill would also be needed, and the required crossing at the River Humber would be likely to prove a costly feature.

While I have made no estimate of the cost of this scheme, I think it probable that it would largely exceed the Scarboro' project, and that it is less favorable in other respects. I therefore do not advise its adoption.

III.—From the Oak Ridge Lakes and the Rivers Don and Rouge (by Gravity.)

This project was reported upon in 1887 by Messrs. McAlpine & Tully, who strongly advocated its adoption.

In a comparison of cost with pumping water from Lake Ontario, they show an enormous annual saving in its favor.

Taking daily supplies of twelve, twenty, thirty and fifty millions of gallons as bases for their calculations, they give the following results:

Daily Supply.	Total cost of Works.	Annual cost (by gravity).	Annual cost (by pumping).	Annual saving effected by adoption of Gravity Scheme.
Gallons.	$	$	$	$
12,000,000	310,102	32,404	83,120	50,716
20,000,000	490,700	44,628	161,787	117,159
30,000,000	873,000	65,012	227,320	162,308
50,000,000	1,380,330	95,213	376,387	281,174

With regard to these figures I have only to say that in my opinion they will not stand close scrutiny. The cost of construction of the gravity works appears to have been underestimated, while the cost of pumping, under ordinary conditions, has clearly been over-stated. Persons desirous of enquiring more fully into these matters are referred to the report itself and to the appendix attached to this report.

The report states that "when the demand for water shall have reached thirty millions of gallons a day, the annual saving by the gravity plan would be

$162,308, and for fifty millions, $281,174, sufficient in each case to repay the whole cost of the gravity works in less than six years."

The concluding paragraph is, however, the most important one to be found in the whole report. It is as follows:

"In conclusion we have to state that our preliminary examinations have shown that an abundant supply of pure and wholesome water for any possible future demand can be obtained from the districts herein described; that it can be delivered at the same or considerable greater elevation than the Rosehill Reservoir, at a cost, the annual interest of which, including the expense of management and renewals, will be so much less than the expense of furnishing an equal quantity by pumping, that the saving in considerably less than ten years will be equal to the whole cost of the proposed gravity works."

After a careful perusal of the report and a partial inspection of the district under consideration, I regret that I feel compelled to differ and entirely dissent from the views, estimates and conclusions arrived at by the engineers who prepared the report.

Chemical analyses and ordinary observation show that the water supply from a large part of the district is impure and unfit for domestic consumption, and in my opinion it cannot be purified and utilized without entailing enormous and unjustifiable expense, far beyond the estimates. I do not believe that the scheme, if carried into effect, would prove satisfactory, and I advise its rejection.

IV.—From Lake Simcoe.

This scheme having been pretty thoroughly looked into in past years and especially reported upon by Messrs. Hering & Gray in 1889, and by a Committee of the City Council in 1891, I did not feel myself justified in incurring any expense in undertaking further detailed investigations. I have, therefore, after examining the different reports, confined myself to a visit to the locality, a sail over a portion of the lake and a cursory examination of the points from which it has been proposed to draw the supply.

Messrs. Hering & Gray estimated the cost of the completed scheme to be "at least $7,711,325," exclusive of land damages. What the additional cost of these damages would be is an unknown quantity.

There are many advocates of this project, some of whom, I believe, claim that the cost has been greatly over-estimated, and that there are ways and means by which the estimates may be reduced. I have not attempted to examine critically into these differences, not only because such an examination would involve an expenditure which I had no means of meeting, but because the engineers who made the surveys and estimates are competent experts in whom every confidence can be placed.

Without going further into the matter, it is sufficient to know that the pipe line is about forty-six miles in length, and that ten miles of tunnelling are required, in order to conclude that the cost must necessarily be enormous, and that, even supposing the estimates can be largely reduced, the project, for the present and under existing circumstances, is impracticable.

I should, perhaps, add that the chemical analysis of Lake Simcoe water shows it to be greatly inferior to that of Lake Ontario, so that, even assuming that an economical scheme for bringing Lake Simcoe water to the City could be devised, it would still be inadvisable to adopt it when a better and purer supply lies at our doors.

V.—From Wells Sunk in the Gravel Beds North of the City.

"I understand that there are two rival companies interested in this project, but as their proposals are not in my possession, I am unable to refer to them. I may, however, say that I visited North Toronto in company with some of the projectors in April last, with a view to gaining some knowledge of the source of supply.

I was shown the North Toronto Pumping Station, and an excavation in the gravel about a quarter of a mile distant therefrom, from which a small stream of water was flowing.

The North Toronto Pumping Station is supplied from a well adjoining, about 18 feet in diameter and 24 feet in depth, the normal depth of water in the well being about 8 feet. The total daily consumption was stated by the engineer in charge to be about 8,000 gallons. This quantity of water is raised in about two and a half hours, and lowers the water in the well about 4 feet.

There is no other water visible except what I have mentioned above. The theory of the promoters is that there is an immense underground flow from Lake Simcoe through the gravelly sub-soil, and that it can be advantageously tapped by means of driven wells in the vicinity referred to, and thence drawn off by gravity to the City after being raised by pumps to the surface.

I am not in a position to deny the existence of the underground river, but, considering the expense that would be involved in making satisfactory tests, the uncertainty as to the supply in any large quantity holding out, and the extreme improbability of being able to obtain anything approaching the required quantity of water from this source, coupled with the fact that it would still require to be pumped, I think I am justified in concluding that the outlook does not seem sufficiently encouraging to warrant further consideration of this project.

Since writing the above, I have ascertained that there is now very little water in the well referred to, and that it can be pumped dry in about ten minutes.

VI.—From Springs and Artesian Wells in the Township of Erin.

This locality was visited early in April. Its height above Lake Ontario is about 1,000 feet, and its distance from the centre of the City in a direct line is about 56 miles. Three or four flowing springs of exceptionally clear and sparkling water were pointed out. It was subsequently learned that this water is as exceptionally hard as it is bright. Mr. Vanderlip, who first called attention to this source of supply, also pointed out the locality of a bore-hole in the same vicinity, which had been sunk in prospecting for oil some years previously. He stated that no oil was discovered, but that at a depth of 80 or 90 feet the boring

tool suddenly dropped about eight feet, and that water immedialely rushed to the surface. The bore hole is not now accessible, as it has long since been filled in and ploughed over, and nothing is to be seen except a puddle of water in a field to mark the spot.

The prospects of obtaining a considerable quantity of water from this locality appear greatly better than at North Toronto, but if it should prove to be as hard as that flowing from the springs in the same locality (which seems probable) it would be unfit for general use.

Under such circumstances, and considering the enormous expense which would have to be incurred in bringing the water so great a distance, I fear the project cannot be seriously entertained.

VII.—From the Vicinity of the Present Intake.

After looking into all the possible sources of supply—so far as they are known to me—the conclusion I have reached is that Lake Ontario can be relied upon to furnish better water than can be obtained from any other quarter within reach, and that it is the proper reservoir from which to draw the supply.

I am also of opinion that the position of the present intake was wisely selected, and that the future water supply can be obtained from the same vicinity, not only to best advantage, but that the difficulties and expense which would be involved in making any radical change are so great that it would be unwise to go elsewhere.

The question of the disposal of City sewage naturally presents itself in connection with any scheme for drawing the water supply from Lake Ontario.

While it cannot be denied that all fæcal matters ought properly to be returned to the earth from which they have their origin, and that, theoretically, it is wrong in principle and dangerous to discharge sewage into the same body of water from which water may be drawn for domestic use, yet it is well, and in fact we are forced to look at this question from a practical standpoint.

This leads to the enquiry as to how far and to what extent injurious effects are to be feared from a continuance of the practice, assuming, of course, that ordinary safeguards are adopted.

If we take a hasty glance at our own case as it has existed ever since the foundation of the City, we find that Toronto, up to the present time, has continued to pour its crude sewage into the bay in front of its own doors, and for a long period pumped its drinking water directly from the same bay. We find to-day that the bulk of the sewage of 200,000 people is discharged into the same water from which the domestic supply is drawn, and within a radius of three miles from the Water Works intake, and yet chemical and bacteriological tests show that the water at the intake is practically pure and wholesome. The health of the City also corroborates the correctness of these tests.

If we look a little further, the case appears still more striking when we consider the millions of human beings residing on the shores of the great lakes and on the rivers emptying therein, all of whom pour their sewage and waste products into the same waters, which receive also the drainage from hundreds of

thousands of acres of cultivated lands with all the accompanying impurities from freshly manured fields barn yards, privies and millions of cattle.

The inference to be drawn is that all such foul matters, within certain limitations, decompose and undergo a process of self-purification after being discharged into a large body of fresh water, and that beyond a certain distance from the point of pollution, no injurious effects are to be traced or feared. What that precise distance is has never been definitely or satisfactorily determined so as to admit of direct calculation or the application of any standard rule. Each separate case requires special investigation and careful study, as local conditions must of necessity be considered.

Among the most recent investigations on this subject with which I am acquainted are those which were carried on in the town of Zurich, Switzerland, containing, with its suburbs, about 100,000 inhabitants. The average delivery of sewage from the town is stated to be 4,400,000 gallons, and the maximum 11,000,000 gallons per day. This sewage is discharged into the River Limmet, which is about 98 feet in width and 6½ feet in depth, with an average daily flow of about 2,000,000,000 gallons, and a mean velocity of about four miles per hour. The conclusions arrived at in this case were as follows:

* 1. "That 96 per cent. of the precipitation takes place within 0.3 mile below the sewage outfall.

2. "That within six miles of the sewage outfall the number of bacteria falls to the number immediately above that point.

3. "That the greater the volume and velocity of the river, the slower is the rate of self-purification.

4. "That so far as concerns the sewage, the rate of self-purification is not influenced by meteorological changes.

5. "That under the conditions described, and provided there are no intermediate sources of pollution, a river such as the Limmet, flowing at the mean velocity of about four miles per hour, will purify itself within a distance of about sixteen miles from the point of pollution."

I have dwelt rather fully upon this subject, in order to show that providing the City sewage is discharged into the lake at a sufficient distance from the Water Works intake, no injurious effects need be anticipated. What the safe distance is, remains a matter for further investigation, and it is a question which must before long receive attention, if the City continues to increase in population, as it undoubtedly will.

At the present time the water supply is drawn from Lake Ontario, at the bell-buoy crib, at a depth of twenty-one feet below zero level of the lake; the renovation of the 6-ft. steel pipe extension to a depth of seventy-five feet not being yet quite completed. The water flows through 2,357 feet of wooden conduit six feet in internal diameter to the shore crib on Toronto Island. Thence

* Minutes of Proceedings of the Institution of Civil Engineers, Vol. CXI.

the water is conducted through a 5-ft. steel conduit to Hanlan's crib, a distance of 6,027 feet, and thence through a double line of pipes across the harbor, a distance of about 4,600 feet, to the Pumping Station, one pipe being of steel, four feet in diameter, and the other cast iron, three feet in diameter.

The 6-ft. wooden conduit is partially filled with sand, but whether the sand finds its way through defective joints in this wooden conduit or not is at present uncertain. It is a difficult matter to determine beyond doubt what is the actual condition of this conduit, as the water supply cannot be shut off for a sufficient length of time to admit of examination.

The 5-ft. steel pipe also contains sand in some places, and it has, unfortunately, been laid so irregularly and at so high a level that it cannot be relied upon to furnish all the water required in the City at times when the lake may fall more than one foot below zero level, which sometimes happens.

The 4-ft. steel pipe across the harbor cannot safely be relied upon, owing to its liability to damage by reason of its shallowness in some places, and also by reason of its exposed position in the bottom of the harbor across the ship channel, where it lies unprotected.

The 3-ft. cast iron pipe across the harbor is believed to be in perfect condition, but it is too small of itself to deliver all the water required in case of damage to the 4 ft. pipe.

Under these circumstances it becomes necessary to devise means whereby these defects may be overcome and the required water supply delivered at the Pumping Station with reasonable assurance that it will not suddenly be cut off, diminished or polluted, by reason of the lake falling to a low level or from accidents which are liable to happen at any moment.

Different methods have been proposed with the view to remedying these defects and lessening the risks, either partially or wholly, and others have suggested themselves after a study of the questions involved.

The following is a list of all these proposals and suggestions:

1. A new steel conduit across the harbor.

2. A tunnel under the harbor and Island and into the lake to a new inlet.

3. Pipes laid in a tunnel under the harbor.

4. An auxiliary pumping station on the Island and forcing the water through the present conduits across the harbor to the pump-well.

5. Transferring the Main Pumping Station to the Island, and pumping the water through either the present conduits or through new pipes laid across the harbor.

6. The same as the above, only that the force main or mains should be carried across the western entrance to the harbor on a bridge.

7. A tunnel under the harbor and a new conduit across the Island.

I will briefly refer to each of these projects in the order in which they are given :

(1) A new steel conduit across the harbor would be largely open to the same objections as apply to the existing pipe, and does not wholly meet the case.

(2) A tunnel under the harbor and Island, carried out into the lake to a new inlet in deep water, would undoubtedly be an effective remedy, if practicable ; but before any opinion could be formed on this subject, a complete set of borings would have to be made, and the investigations would prove tedious and expensive. The project would also be a very costly one, and need scarcely be considered when the same objects can be attained for far less money, as it is unnecessary to tunnel under the Island and risky to attempt tunnelling out into the lake anywhere in the vicinity of Toronto Island.

(3) Pipes laid in a tunnel under the harbor would also be an effective remedy, so far as danger from pollution by bay water is concerned, but the plan would prove an exceedingly expensive one, and does not meet all the requirements of the case.

(4) The idea of providing an auxiliary pumping plant on the Island was, I understand, first proposed in 1887 by Elias Rogers, Esq., who was then an Alderman. The scheme was investigated, reported upon and recommended by Messrs. Geo. C. Robb and John Galt in the same year, the sole object, apparently, being to provide some "temporary expedient" for increasing the water supply "until such time as a general and permanent system may be devised and carried out." The plan contemplated the erection of a tank or stand pipe at the Island crib and raising the water by means of a centrifugal pump, so as to create "an artificial head" of about twenty feet above the level of the lake at that point, with a view of forcing 22,000,000 gallons of water into the pump-well through the old wooden 4-ft. pipe in Blockhouse Bay and the 3-ft. iron pipe in the harbor, as these pipes were found to be inadequate. The estimated cost was stated to be $29,000 ; but the cost of operation is not given.

At the time the above report was made, the present 5-ft. and 4-ft. steel pipes from the Island Crib to the City had not been laid, so that the necessity for such an auxiliary pumping plant for the purpose of increasing the supply no longer exists.

The scheme has, however, recently been revived, with the view not to increasing the delivery of the pipes, but to prevent the influx of polluted bay water in case of the pipes being leaky.

In regard to this scheme, I may say in the first place that the estimates of 1887 would be quite inadequate to cover the cost of the enlarged pumping plant which would now be needed, if a sufficient and constant head is always to be maintained to force the whole water supply through the existing conduits under pressure, and the annual cost of maintenance would be very considerable.

In the second place, a complicated state of affairs would be set up which might at any moment lead to disastrous results by the flooding of the engine

houses at the Main Pumping Station. This is a danger which does not appear to have been considered in the original scheme, and to obviate which would involve considerable additional expense.

In the third place, I may say that the principle is wrong, and if carried out it would not, in my opinion, prove beneficial or satisfactory. Should leaks at any time be found to exist in the conduit through which the water was being forced, it would result in the waste of large quantities of fuel in pumping lake water into the bay and harbor. Common prudence and economy would require that the leaks should be found and stopped with the least practicable delay, so that after this remedy (which is necessary in any case) had been applied, there would be no further use for the auxiliary pumping station. The proposal, therefore, appears to me to be an absurd one.

(5) The scheme of transferring the Main Pumping Station to Toronto Island and pumping the supply through either the present conduits or through new pipes to be laid across the harbor, is open to the grave objection that in the event of serious leakage, a break, or accident to the force main under water, the entire water supply to the City might be suddenly cut off, and considerable time would necessarily be consumed in ascertaining exactly where the defects existed and in effecting repairs. This sole objection is too serious to warrant the adoption of any such scheme.

(6) The alternative project of placing the Main Pumping Station on the Island, and carrying duplicate force mains across the western entrance on a bridge, at or near the Queen's wharf, might be seriously considered if the construction of a bridge of moderate height across the ship channel would be allowed. Such a bridge would undoubtedly be of very great service to the residents and to visitors to the Island, in addition to its affording the means of supporting the force mains and of rendering them easily accessible at all times. The centre span of the bridge would require to be about 400 feet in length across the channel, with long approaches both north and south.

The Harbor Commissioners have been communicated with on the subject. They will not sanction a pier in the centre of the channel, and they require clear head-room above the water level of 150 feet. This latter requirement renders the scheme impracticable not only on account of the enormous expense of the structure that would be required, but also on account of the excessively heavy gradients that would be involved, which would render the bridge unserviceable for traffic.

(7) A tunnel under the harbor, coupled with a new conduit across Toronto Island and into the lake to a new intake, appears to me to be the best solution of the problem. It is also one of the cheapest and safest plans of any so far proposed, and I recommend its adoption. In my opinion it is unsafe to rely upon the existing conduits, for reasons which I have already explained, and *I advise that no time be lost in starting the works*, the construction of which will probably take two years.

Borings have been made at the Water Works wharf and at Hanlan's Point, for the purpose of ascertaining the nature of the material to be encountered. Shale rock was found at a depth of 13 feet below lake level (zero) at the pumping station, and at 55½ feet in depth at Hanlan's Point. The rock generally is firm and solid, but is of such a nature that the tunnel would require to be lined throughout its whole length, which is a little over a mile. A few small water-bearing seams were encountered in boring through the upper layers of the rock, and more borings are required before the courses of these seams can be traced with any certainty and the best level for the tunnel determined. If, however, it is kept down about 130 feet below the surface of the harbor, the borings so far taken indicate that no water will be encountered at that depth to hinder the vigorous prosecution of the work.

My estimate of the works which are necessary in order to complete this project in a proper manner is as follows (exclusive of land damages):

Tunnel, 6 ft. 6-in. in internal diameter, 5,500 feet in length, lined with brickwork, including necessary shaft at each end	$250,000 00
Screen chamber, valve house and connections at Main Pumping Station	20,000 00
New 5-ft. steel pipe, 900 feet in length, connecting existing 6-ft. pipe in Blockhouse Bay with southern end of tunnel, including specials and connections	19,000 00
New 6-ft. steel pipe, 2,400 feet in length (to replace existing wooden pipe), between shore crib and bell-buoy crib, including connections and anchorage	*60,000 00
Valve house and settling chamber at south end of tunnel	18,000 00
New 6-ft. steel conduit, 7,000 feet in length, across Toronto Island from south end of tunnel and into Lake Ontario, including new intake, valve house and settling chamber	158,000 00
	$525,000 00

In this estimate the tunnel is designed of ample capacity to deliver at the Pumping Station 75,000,000 gallons per day, so that no enlargement or duplication will be necessary until the City has trebled its present population. Provision is also made for a duplicate 6-ft. steel conduit across the Island in order to avoid any tearing down or expensive alterations when such an addition becomes necessary.

In addition to the project I have recommended and outlined above, further works are required in connection with the system of distribution.

I have already recommended that a new 24-in. main should be laid along Front Street, from Simcoe to Sherbourne Street, for the double purpose of relieving the pumps and force mains to some extent and of affording better protection against fire in the heart of the City than can now be obtained. I beg to renew this recommendation.

* This expenditure may possibly be saved for a time, if, on further investigation, the existing 6-ft. wooden conduit should be found suitable to be retained.

I also recommend that a new 36-in. force main be laid from the intersection of Bathurst and College Streets, up Bathurst Street, along Dupont, McPherson and Yonge Streets, and thence into Rose Hill Reservoir, as shown on the accompanying plan. The object of this additional main is that it will not only greatly improve the system for fire protection and general service, but that it will be a safeguard against accidents at the Main Pumping Station and will lessen the risk of breakage and damage to the existing force mains, especially to those on Front Street and across the railway properties. It will also afford the means of maintaining the best possible pressure on the mains at times when it may be necessary to stop all pumping operations which sometimes cannot be avoided.

I also recommend that the 30-in. main on Wellington Street be extended eastwardly from John Street to Simcoe Street, for the purpose of improving the circulation and rendering the system more complete and secure against accidents.

I also recommend that a new 12-in. main be laid on Avenue Road, from Davenport Road to Bloor Street, for the purpose of improving the supply in the high service district.

The following is the estimate of the entire works herein recommended :

Total cost of tunnel scheme as outlined above.....	$525,000
16,000 ft. of 36-in. force main, from intersection of Bathurst and College Streets to Rose Hill reservoir, including valves and specials, etc	135,000
1,000 ft. of 30-in. pipe on Wellington Street, from John to Simcoe Street, including valves, etc	8,000
24-in. main on Front Street, from Simcoe to Sherbourne Street, including valves and specials, etc..	36,000
12-in. main on Avenue Road, from Davenport Road to Bloor Street....	5,500
Total	$710,000

In addition to the above there are minor improvements and alterations which will be required from time to time, but they are not deemed of sufficient importance to call for special reference in this report. I may, however, say that the district on the east side of the River Don, lying to the north of Gerrard Street, will before very long require attention. It lies at a high elevation, and is supplied off the low service system, which is scarcely adequate under existing arrangements, to afford an effective fire protection service.

Attached hereto is a map showing in outline the improvements I have proposed and recommended, and also an appendix giving the cost of pumping under varying conditions, and other information of interest.

I have the honor to be, Gentlemen,

Your obedient servant,

E. H. KEATING,
City Engineer.

APPENDIX.

(For explanatory notes see page 23.)

SCHEDULE No. 1.

First Cost of Construction of Conduits, Pumping Engines, etc. (exclusive of distribution), Toronto Water Works, and Annual Charges thereon, as at 31st December, 1892.

WORK.	Cost.	Interest Annually.	Sinking Fund per annum.	Total annual charge
	$ c.	$ c	$ c.	$ c.
Works under commission, including wooden and iron conduits, Nos. 1 & 2 pumping engines and buildings, filtering basin and all work between connecting crib and engine house.....	506,802 27	30,408 13	6,410 49	36,818 62
Wooden intake pipe in lake.....	46,344 38	2,317 21	697 54	3,014 75
No. 3 engine and appurtenances (including rebuilding).....	124,295 70	4,971 82	2,216 20	7,188 02
High level station (including new engines and buildings and connections)..... .	66,839 23	2,339 36	1,294 76	3,634 12
New steel conduits and lake intake extension..	189,085 71	6,617.99	3,662 84	10,280 83
Total (gross).....	933,367 29	46,554 51	14,281 83	60,936 34
Less cost of filtering basin and wooden conduit (both abandoned	125,915 02	7,554 90	1,592 68	9,147 58
Total cost of works in use at end of 1892.....	807,452 27	39,039 61	12,689 15	51,788 76
Deduct depreciation of engines Nos. 1 and 2 .	101,874 82	6,112 48	1,288 60	7,401 08
	705,577 45	32,987 13	11,400 55	44,387 68
Deduct difference between cost of No. 3 engine and her value as compared with No. 4 engine. . .	42,738 89	1,709 55	762 03	2,471 58
	662,838 56	31,277 58	10,638 52	41,915 10
Deduct 10 p.c. on remainder of plant for depreciation	64,928 17	2,609 53	877 95	3,487 38
Estimated present value.	597,910 39	28,668 05	9,760 57	38,428 62

SCHEDULE No. 2.

Estimated Value of Conduits and Pumping Plant when Nos. 4 and 5 Engines are completed, and when two additional High Duty Engines are provided to replace Nos. 1 and 2, and also providing for increasing Conduit capacity for future needs.

WORK.	Value.	Interest on Value.	Sinking Fund for do.	Total annual charge
	$ c.	$ c.	$ c.	$ c.
Estimated present value, as per Schedule No. 1.	597,910 39	28,668 05	9,760 57	38,428 62
*Estimated cost of Nos. 4 and 5 engines, connections and buildings, etc.	200,000 00	7,000 00	3,874 26	10,874 26
Total	797,910 39	35,668 05	13,634 83	49,302 88
Add cost of Nos. 6 and 7 engines, of like capacity as 4 and 5	200,000 00	7,000 00	3,874 26	10,874 26
	997,910 39	42,668 05	17,509 09	60,177 14
Add estimated cost for increasing conduit capacity for future needs.. .	525,000 00	18,375 00	10,169 94	28,544 94
Total	1,522,910 39	61,043 05	27,679 03	88,722 08

* These engines were paid for out of current revenue, and not from debentures.

SCHEDULE No. 3.

Expenditure on Account of Pumping Stations, giving average cost of pumping 1,000 gallons of water for the year 1892.

Main Pumping Station (fuel, wages and general maintenance)	$103,202 91	
High Level Station (fuel, wages and general maintenance)	10,167 69	
		$113,370 60

	Gallons.
Quantity of water pumped (after allowing for slip)	7,001,674,226
" re-pumped at High Level Station	1,340,209,130

Cost on above basis of pumping per 1,000 gallons for both Stations	1.619c.
" " " at Main Pumping Station	1.474c.
" " " at High Level Station	0.758c.
Interest and sinking fund paid in 1892, as per Schedule No. 1	$60,936 34
Rate of do. per 1,000 gallons pumped	0.870c.
Cost of pumping per 1,000 gallons	1.619c.
" interest and sinking fund per 1,000 gallons	.870c.
Total cost of pumping	2.489c.
Interest and sinking fund, if works that have been abandoned are deducted	$51,788 76
Making cost of pumping	1.619c.
" interest and sinking fund	.739c.
Total cost per 1,000 gallons	2.358c.
If further allowance is made for depreciated value of plant, the interest and sinking fund would be	$38,428 62
Making the cost of pumping per 1,000 gallons	1.619c.
Cost of interest and sinking fund per 1,000 gallons	.548c.
Total cost of pumping per 1,000 gallons	2.167c.

SCHEDULE No. 4.

Estimated cost of pumping when Nos. 4 and 5 High Duty Engines are completed.

Capacity of engines	7,154,000,000 gallons net.	
Average of No. 4, since being put in commission	.441 gallons per pound of coal.	
Coal required 8 111 $\frac{2}{2000}$, @ $4.50	$36,500 00	
Labor	20,567 75	
Repairs, lubricants, etc.	10,000 00	
		$67,067 75
Interest and sinking fund on value of plant (Schedule No. 2)		49,302 88
		$116,370 63
Cost of fuel per 1,000 gallons	.510c.	
" labor, etc	.427c.	
" interest and sinking fund	.689c.	
Total cost per 1,000 gallons	1.626c.	

SCHEDULE No. 5.

Estimated cost of pumping when consumption shall have reached 40,000,000 gallons per day and pumping capacity has been increased by the addition of two new High Duty Engines (6 and 7), and also including cost of increasing conduit capacity for future needs.

Capacity of engines, 14,308,000,000 gallons (net average of No. 4 forming basis of calculation for coal).

Coal required, 16,222 tons, at $4.50	$73,000 00
Labor	41,135 50
Repairs, lubricants, etc.	20,000 00
	$134,135 50
Interest and Sinking Fund, as per Schedule 2	60,177 14
Total annual charge	$194,312 64

If provision is made for additional conduit, to increase daily capacity for future needs, the cost will be:

Coal, labor, repairs, etc., as above		$134,135 50
Interest and Sinking Fund, as above	$60,177 14	
" " on $525,000, as per Schedule No. 2	28,544 94	
		88,722 08
Total cost		$222,857 58
Cost per 1,000 gallons for labor		0.510c.
" " fuel		0.427
" " interest and sinking fund		0.620
Total estimated cost per 1,000 gallons		1.557c.

SCHEDULE No. 6.

Comparison of the actual payments which the City would have to make if one of the proposed offers to supply the City with water at 3c. per 1,000 gallons is accepted, and the estimated cost of pumping the same water, based upon the actual record of No. 4 engine:

By Pumping—

20,000,000 gallons daily = 7,154,000,000 yearly, after allowing for slip:

Cost of pumping, as per Schedule No. 4		$67,067 75
Interest and sinking fund upon total debt of works, $226,000 00		
" " " cost of Engines Nos. 4 and 5	10,874 26	
		236,874 26
Maintenance of other branches of Department		80,000 00
		$383,912 01

By Private supply—

7,154,000,000 gallons at 3c	$214,620 00	
Interest on sinking fund and debenture debt	226,000 00	
Cost of maintenance of remaining branches	80,000 00	
		520,620 00
Difference in favor of pumping		$136,677 99

Cost per 1,000 gallons by private supply	7.277c.
" " pumping	5.366
Difference in favor of pumping	1.911c. per 1,000 gals.

In other words:

Estimated revenue from water works 1895	$440,000 00
Cost if water supplied by private company	520,620 00
To be raised by taxation or by increased water rates	$80,620 00

SCHEDULE No. 7.

Comparison of relative cost of water by pumping and private supply when consumption shall have reached 40,000,000 gallons per day and high duty pumping plant is provided as per Schedule No. 5.

By Pumping—

Cost of pumping as per Schedule No. 5	$134,135 00	
Interest and sinking fund on total debt	226,000 00	
Maintenance of remainder of works	80,000 00	
Interest and sinking fund on engines 4, 5, 6 and 7	21,748 52	
		461,884 02

By Private Supply—

14,308,000,000 gallons at 3c.	429,240 00	
Interest and sinking fund on debt	226,000 00	
Maintenance of remaining branches	80,000 00	
		735,240 00
Annual difference in favor of pumping		$273,355 98

If provision is made for additional conduit capacity to provide for future needs the cost will be :

By Pumping—

Annual cost as above	$461,884 02	
" of additional interest and sinking fund, as per Schedule No. 2	28,544 94	
		$490,428 96

By Private Supply—

Annual cost as above	735,240 00
Excess of cost by private supply	$244,811 04

SCHEDULE No. 8.

Comparative statement showing the actual cost of the City's water supply for 1892, and what it would have been had the City been supplied for that year by private parties at 3c. per thousand gallons.

Actual cost by Pumping—		
Cost of fuel, labor and general maintenance of the main pumping station	$103,202 91	
Ditto high level station	10,167 69	
	$113,370 60	
Maintenance of other branches of Department	66,845 19	
Interest and sinking fund upon total debenture debt for water works purposes	222,626 00	
		$402,841 79
Cost by Private Supply—		
7,001,674,226 gallons at 3c. per 1,000	$210,050 22	
Maintenance of branches of Department other than main and high level stations	66,845 19	
Interest and sinking fund on total debenture debt for water works purposes	222,626 00	
		499,521 41
Excess of cost by private supply at 3c per 1,000 gallons.		$96,679 62

Revenue and Expenditure:

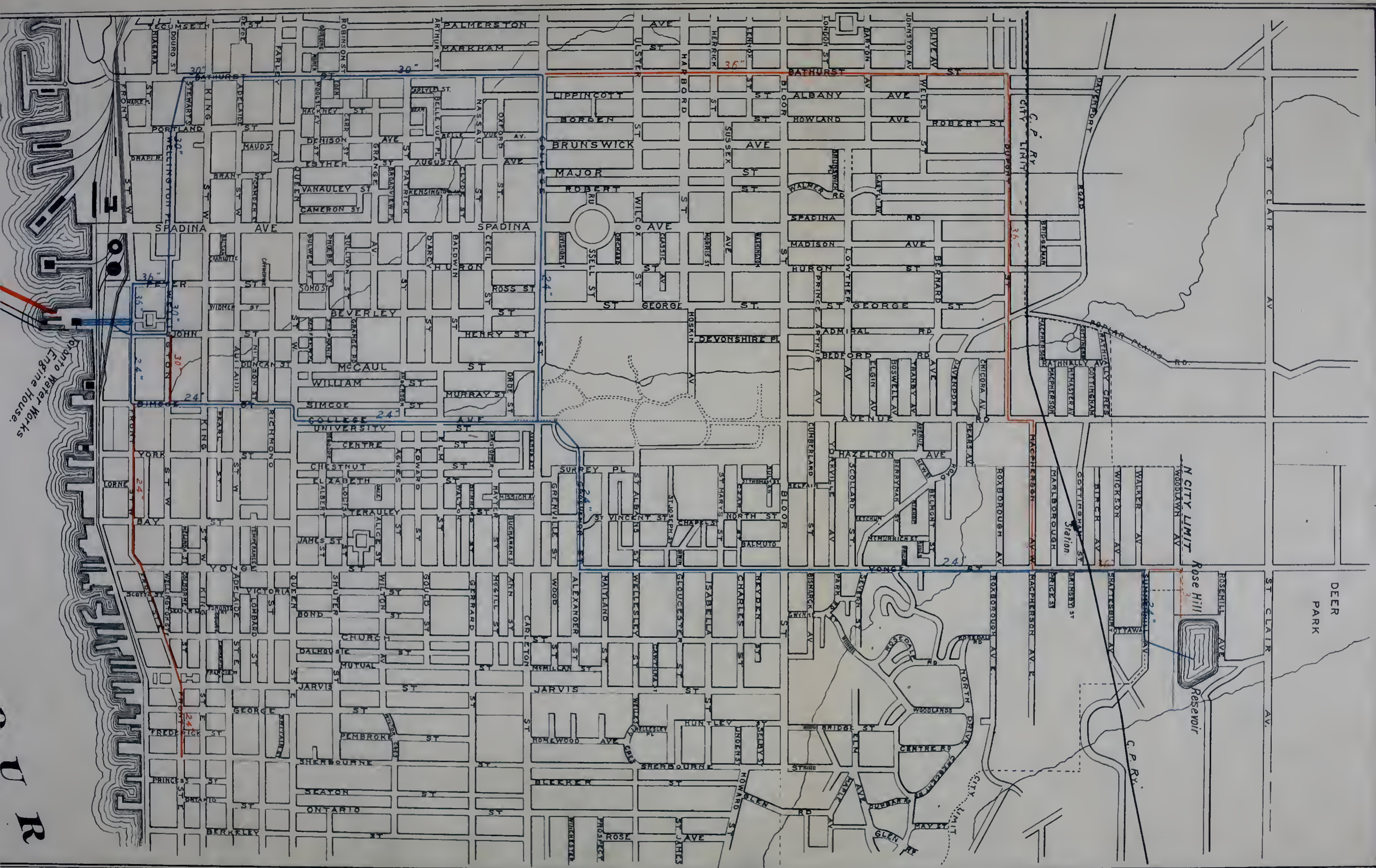
Revenue from water works for 1892	$449,252 78
Cost by pumping as above	402,841 79
Surplus of revenue over expenditure	$46,410 99

By Private Supply the result would have been:

Revenue for the year	$449,252 78
Cost of water as above	499,521 41
Deficit, which would have been met by increased taxation or by increased water rates	$50,268 53

In the calculations for Schedules 6, 7 and 8 the cost of remodelling the present system in order to distribute the water from the north instead of from the south has not been taken into account.


TORONTO HARBOUR
TORONTO WATER WORKS.
PLAN
Shewing Proposed Enlargement and Improvements
to accompany City Engineer's Report Dated Oct. 1893.
Scale.
10 9 8 7 6 5 4 3 2 1 0 1000 2000 3000 4000 Feet.
NOTE — Red Lines shew proposed improvements.
Blue & Black Lines shew existing line of Pipe.
Toronto Water Works Engine House.
TUNNEL 6'6" DIAM. 3500 Ft. Long.
4 Ft Steel Pipe
Hanlan's Crib
LAGOON
HANLAN'S POINT
5 Ft Steel Conduit
BLOCK HOUSE BAY
MEAD'S WHARF
WIMAN BATHS
6 Ft. Steel Pipe 1000 Ft.
Shore Crib
LIGHT HOUSE
VALVE HOUSE & SETTLING CHAMBER
LIGHT HOUSE POINT
6 Ft Wooden Pipe
6 FT STEEL PIPE TO REPLACE WOODEN ONE
Bell Buoy
PROPOSED NEW INTAKE
Present Deep Water Intake 75' deep.
LAKE ONTARIO
E. H. Keating
CITY ENGINEER
Toronto, Oct. 1893.
Alexander & Cable Co Ltd Toronto



Toronto Water Works Engine House.
Rose Hill Reservoir
DEER PARK
N CITY LIMIT
CITY LIMIT
C.P. RY
Station
PALMERSTON
MARKHAM
BATHURST ST
LIPPINCOTT
BORDEN
BRUNSWICK AVE
MAJOR ST
ROBERT ST
SPADINA AVE
SPADINA RD
HURON ST
ST GEORGE ST
BEVERLEY ST
McCAUL ST
WILLIAM
SIMCOE
COLLEGE AVE
UNIVERSITY
CENTRE
CHESTNUT
ELIZABETH
TERAULEY
JAMES ST
YONGE ST
BAY
YORK
KING
QUEEN
ADELAIDE
RICHMOND
FRONT
PORTLAND
WELLINGTON PL
JOHN
PETER
DEVONSHIRE PL
BLOOR ST
ALBANY AVE
HOWLAND AVE
MADISON AVE
BERNARD
DAVENPORT ROAD
DUPONT
POPLAR PLAINS RD
AVENUE RD
HAZELTON AVE
YORKVILLE AV
SCOLLARD
ROXBOROUGH AV
MACPHERSON AV
ST CLAIR AV
CHURCH
JARVIS ST
SHERBOURNE
WELLESLEY
ISABELLA
CHARLES
GLOUCESTER
ALEXANDER
CARLETON
GERRARD
SHUTER
GEORGE
FREDERICK ST
PRINCESS ST
BERKELEY
ONTARIO
SEATON
PEMBROKE
BLEEKER
HOMEWOOD AVE
HOWARD ST
GLEN RD
NORTH DRIVE
ROSEDALE RD
WOODLANDS
CENTRE RD
HUNTLEY
ST JAMES AVE
ROSE AVE
WINCHESTER
PROSPECT
30"
36"
24"
U R

EXPLANATORY NOTES.

Schedule No. 1 refers to the actual cost of the pumping plant, including the wharves, engine houses, pumping engines, and all plant south of the engine house, also the high level pumping station. The gross cost comprises the amount paid for the construction of these works (as per annual reports of the Commissioners and Water Works Department), the annual charge for interest and sinking fund thereon being also shown. The first deduction made from this amount is the cost of the filtering basin on the Island, and the four-foot wooden conduit between Hanlan's Point and the connecting crib on the Island, both of which have been abandoned. The result is the cost of the works actually in use on 31st December, 1892, and the annual charges thereon. Deductions are then made for depreciation of Nos. 1, 2 and 3 engines, being the difference between the actual cost thereof, as included in the gross cost, and their present value. This was arrived at as follows: No. 1 is valued at $7,000, being the amount the original builders of this engine offered to allow for the engine and boilers as part payment for another engine. The values of Nos. 2 and 3 are based upon their capacity and guaranteed duty as compared with No. 4 engine, which cost $54,418.

A deduction of 10 per cent. is next made for depreciation of the remainder of the plant. This is, I think, a small percentage for plant that has been in use on an average upwards of ten years

Schedule No 2 shows the various additions to be made to the total value of plant, as per No. 1, for new engines, also probable extensions required in the near future.

Schedule No. 3 gives the actual cost of pumping per 1,000 gallons with low duty engines, 1892; and Schedules Nos. 4 and 5 the cost of pumping 20 and 40 million gallons per day respectively with high duty engines of the same type as No. 4—the calculations being based upon the actual record of that engine for the eight months during which it has been in service—the annual charge for interest and sinking fund on cost of additional plant being also included. No. 3 Schedule is given for information and comparison, but cannot fairly be taken as a basis of calculation for the future, the record being made by low duty engines, which were also badly in need of repair.

Schedules Nos. 6, 7 and 8 are comparative, showing the relative cost between a water supply obtained by pumping and that purchased from private parties at 3 cents per 1,000 gallons, the first two schedules being calculated for a daily supply of 20 and 40 million gallons respectively. Schedule No. 8 shows what the City would have had to pay in 1892 for the water actually provided had it been supplied by a company at three cents per thousand gallons, and also gives the actual cost by the present system. From this statement it appears that had the water been supplied by private parties at the rate above named, instead of the current revenue being sufficient to meet the working expenses and give a surplus of $49,500, as was the case, there would have been a deficit of $50,000 on water works account, which would have had to be met by increased taxation or by an increase in the water rates.

In Schedules Nos. 4, 5, 6 and 7, no allowance has been made for repumping to the high level district, as the proportion of the total quantity which would require to be repumped is unknown. In 1892, however, the cost of the high level station was less than one-tenth of that of the main station, and the quantity of water repumped was less than one-fifth of the total supply.

Taking the relative cost of repumping at the high level station as one-tenth that at the main station, the cost per thousand gallons in Nos. 4 and 5 would be increased by 0.037 cents. A like amount should also be added to the cost per thousand gallons by pumping in Schedules Nos. 6 and 7.

In calculating the annual cost of water by private supply for Schedules Nos. 6, 7 and 8 the large expense which would necessarily be incurred in remodelling the distribution owing to the alteration in the method of supply has not been taken into consideration.

CHAS. A. MATTHEWS,
Secretary Water Works Department.

APPENDIX "D."

REPORT ON DUTY TRIAL

OF THE BLAKE-CROSS COMPOUND FLY-WHEEL HORIZONTAL PUMPING ENGINE No. 4, AT MAIN PUMPING STATION.

APPENDIX "D."

REPORT ON DUTY TRIAL OF THE BLAKE-CROSS COMPOUND FLY-WHEEL HORIZONTAL PUMPING ENGINE No. 4, AT MAIN PUMPING STATION.

E. H. Keating, Esq., City Engineer, Toronto, Canada:

Dear Sir,—In compliance with the following letter, received on February 13th, I have made a duty trial of the Blake-Cross Compound Fly-Wheel Horizontal Pumping Engine, located in the new Engine House of the Toronto Water Works, and beg leave to present a report of the facts obtained by my labors and the conclusion which I have deduced therefrom:

[Copy of letter]

Department of Works,
Toronto, February 13th, 1893.

Edmund B. Weston, Esq., C.E.:

Dear Sir,—You are requested to superintend an ordinary commercial test, for a run of 48 hours, of the pumping plant, viz.: a ten-million-gallon Blake engine, located at Toronto, as a whole, for the purpose of ascertaining the "duty" of the engine (which is equivalent to the number of pounds of water which it can lift one (1) foot high per one hundred (100) pounds of fuel) while pumping at the rate of ten million (10,000,000) imperial gallons per 24 hours.

The theoretical displacement of the pump-plungers, less 4 per cent. for "slip," is to be used in calculating the quantity of water pumped.

You are also requested to state the theoretical duty of the engine, making no allowance for "slip" in the pumps.

The "fuel" is to be considered as the total quantity of coal fed to the furnaces of the boiler during the test, + the wood × 0.4, used in starting the fires, etc., without making allowance for ashes and clinkers.

Yours truly,

E. H. Keating,
City Engineer.

Wm. Hamilton.

Report.

The trial was commenced on Tuesday, February 14th, at 3.34 p.m., but after a run of five and one-half hours an abnormal noise in one of the pumps caused me to discontinue the trial, for the time being, in order to have an examination made of the interior of the pumps; and, as I was informed at this time, that a screen through which the water passed from the lake conduit to the pump well

had only recently been put in place, and that it was very probable that some foreign substance had got into the pump in question, it was deemed advisable to have the pump well pumped out and cleaned before again beginning the trial. This was done on February 15th, and the valves of both pumps were overhauled at the same time.

When the pumps were examined the majority of the suction valves in the pump in which the noises were discovered were found to have pieces of lizards or fish squeezed under them, and several lizards or fish nearly intact, from eight to eleven inches in length, were found with their heads jammed into the openings in some of the valve seats of this pump. The other pump was in a similar condition, although the quantity of lizards and fish found under the valves was not as great. A considerable number of lizards and fish were also found in the pump well.

Duty Trial.

On Thursday, February 16th, at 10.22 a.m., everything being in readiness, the duty trial was once more commenced, and was continued without interruption until it was completed on Saturday, February 18th, at 11.31 a.m.

The engine, which had been pumping in regular service for a number of hours, was stopped, and at 9.28 a.m. the fires in the boiler furnaces were drawn as quickly as possible and the ash pits cleaned. New fires were kindled at 9.50 a.m., the average steam pressure at the boilers, by gauge, at this time being 71 pounds. At 10.22 a.m., when the engines commenced to pump, the average steam pressure, by gauge, at the boilers was 116 pounds.

It was understood at the beginning of the trial that the engine should be run at full power for 48 hours, and at the end of this period, no more coal was to be put into the furnaces, and the engine was to be allowed to pump as long as the contractors' representative deemed it advisable for it to do so in order to derive all of the benefit possible from the fires upon the grates, as no allowance was to be made for any ashes, clinkers, etc., which should be found upon the grates after the engine had stopped pumping, or which should fall through the grates during the trial. In other words, the total weight of the coal, plus the total weight of the wood multiplied by 0.4, which was to be put into the furnaces, was to be used in computing the duty. One deviation, however, was made from these provisions, as 144.5 pounds of fine coal that dropped through the grates when the fires were first started, was once more put into the furnaces at the latter part of the trial.

At the expiration of the 48 hours specified, the average steam pressure at the boilers, by gauge was 118 pounds. The steam pressure commenced to decrease about 30 minutes later, and at 11.31 a.m., February 18th, when the engine stopped pumping, the average steam pressure at the boilers, by gauge was 54 pounds.

The procedure which was followed in regard to the coal I considered justifiable, in a commercial sense, as it is not the custom of those having charge of

pumping machinery, to have ashes, clinkers, etc., that have been drawn from grates and ash pits, screened or picked over, as the small amount of combustible which would be saved, by either or both of these operations, would not be of sufficient value to compensate for the labor which would be expended in obtaining it.

Three of the four boilers which were furnished with the engine were used. The boiler that was not used, I was informed by those in authority, had been in alternate service with the others, while the engine was pumping, since January 15th of the present year. All four of the boilers were tested 11 days after the trial was completed, by hydrostatic pressure, with hot water, at a pressure of 200 pounds per square inch, by the chief engineer of the "Boiler Inspection and Insurance Company of Canada," whose report, relative to the same, I enclose with this report.

The pressure gauges used upon the boilers, engine and force main, with one exception, were those belonging to the engine and boilers. They were all carefully tested previous to the trial, as well as the thermometers and barometer that were used, and found to be correct. The gauge upon the force main was also tested at the end of the trial and again found to be correct.

The scales used for weighing the coal were tested and verified by the Assistant Inspector of weights and measures.

The manhole plates were removed from the pumps, and the plungers and rods accurately measured.

The distance from the surface of the water in the pump well to the centre of the pressure gauge upon the force main was determined by the aid of a float gauge. The elevation of the zero point of the float gauge was 0.68 feet above the elevation of the centre of the gauge upon the force main. The float gauge was carefully tested before the trial commenced, and was found to have a plus error of 0.27 feet. From the average of the readings of the float gauge, 0.95 feet was therefore subtracted.

The level of the water in the boilers at the beginning of the trial was carefully measured and marked, and the level was brought to the same mark at the end of the trial.

The coal used (Delaware and Hudson) was not of a superior quality.

During the trial, observations of the engine counter, the steam and water gauges, the pump well float gauge, the thermometers, the barometer and the level of the water in the boilers were recorded every half-hour. The half-hourly observations, which were checked from time to time, were recorded by six students from the School of Practical Science, who were divided into two watches of 12 hours each. In addition to the half-hourly observations, a series of observations, averaging about one hour apart, were recorded throughout the trial by myself personally during the 31 hours that I was able to be present, and when I was not present, by an experienced engineer who was detailed to assist me from the Water Department.

As the average of the observations taken from the gauge upon the force main is one of the most important elements that were used in computing the duty, and owing to a slight vibration of its pointer, it was necessary to exercise more than ordinary care in noting the pressure. it may be well for me to state here that the difference between the average of the two sets of observations, mentioned in the foregoing paragraph, of this gauge, is less than one quarter ($\frac{1}{4}$) of a pound.

The head, or the height that the water was pumped, was obtained by adding the feet corresponding to the average pressure of the gauge upon the force main to the average distance from the centre of this gauge to the surface of the water in the pump well. No allowance was made for the friction of the water in passing through the "suction" and pumps, as what I considered was essential, in order to obtain a commercial result, was the actual distance that the water was raised, and not the force that it was necessary to exert in the pumps, in order to do the work.

The coal was weighed by three experienced men detailed from the Water Department, who were divided into three watches of eight hours each. A check was also kept upon the weight of the coal by an experienced assistant detailed from the City Engineer's Department. As in all other matters relating to the trial, great care was exercised in weighing the coal. The cement floor in front of the boilers was cleaned before the trial was commenced, and the only coal that was allowed to remain upon this floor was the coal in the box in which it had been weighed.

Indicator cards were taken at intervals from the steam cylinders and pumps for the purpose of detecting any defective action which might otherwise escape notice.

The following table gives the principal dimensions of the engine and pumps, and the results which were obtained from the observations recorded during the trial.

Dimensions.

Diameter of high-pressure cylinder	29 inches.
" low-pressure "	58 "
" each of the two piston rods	5.5 "
" " " pump plunger	20 "
" " " pump plunger rods	4.5 feet.
Stroke of steam pistons and pump plungers	3.982 "
Diameter of fly-wheel	20 "

Results.

Duration of trial	49 hours, 9 minutes.
Average temperature of water in pump well	33 degrees.
Weight of one cubic foot of water	62.42 pounds.
Displacement per revolution of the pump plungers, no allowance being made for slip	33.871 cubic feet.
Displacement per revolution of the pump plungers, allowing 4 per cent. for slip	32.516 "

Total number of revolutions	112,838	
Average number of revolutions per minute	38.263	
Average pressure of gauge upon force main	95.56	pounds.
Equivalent height	220.1	feet.
Average distance from surface of water in pump well to centre of gauge upon force main	14.9	"
Head, or height pumped above surface of water in pump well	235	"
Pressure of the atmosphere (71°)	29.81	inches.
Average steam pressure at boilers by gauge	116.4	pounds.
Average steam pressure at engine by gauge	114.0	"
Average vacuum by gauge	25.2	inches.
Wood used in starting fires X 0.4	280.	pounds.
Coal put into the furnaces	50,414.	"
Total weight of coal and equivalent wood put into the furnaces during the trial	50,694.	"
Ashes, clinkers, etc., that dropped through the grates, not including 144.5 pounds of fine coal that was put back into the furnaces	6 580.	"
Ashes, clinkers, etc., drawn from the grates at the end of the trial	697.	"
Total number of gallons pumped, no allowance being made for slip	23,856,548	imp. gallons.
Total number of gallons pumped, allowing four per cent. for slip	22,902,286	"
Average number of gallons pumped per 24 hours, no allowance being made for slip	11,649,136	"
Average number of gallons pumped per 24 hours, allowing four per cent. for slip	11,183,286	"
DUTY, no allowance being made for slip, per 100 pounds of coal	110,591,000	foot-pounds.
DUTY, allowing four per cent. for slip per 100 pounds of coal	106,167,000	"

The engine was pumping directly from the pump well into the City mains during the trial, and the management of the engine and boilers was exclusively under the direction of the Contractors' representative. The engine was run by three men, who were divided into three watches of eight hours each. Two of these men were employed by the city and the third was furnished by the contractors. The firing of the boilers was performed by three firemen employed by the city, who were divided into three watches of eight hours each.

When the duty trial was finished the manhole covers were removed from the pumps and the pump valves examined. They all appeared to be in their normal condition, with the exception of one valve, which had a small piece of wood wedged under it.

A short time after the pumps had been examined, at the conclusion of the duty trial, new fires were started in the boiler furnaces, and the engine was run for more than one hour and one half at an average rate of 39,820 revolutions per minute. The amount of water displaced by the pump plungers during this time, no allowance being made for slip, was at the rate of 12,123,164 gallons per 24 hours, and, allowing four per cent. for slip, at the rate of 11,638,238 gals. per 24 hours.

During the trial the engine boilers and accessories worked in a satisfactory manner, and if the quality of the coal that was used had been equal to the quality of coal which I can recall as having been used during six of the engine trials in which I have taken an active part or have been present as a spectator, I do not hesitate to state that in my opinion the duty of the engine would have been increased at least 5,000,000 foot pounds.

As I close, I wish to express my appreciation of the valuable services that were rendered during the trial by the men who assisted me from the City Engineer's office, the School of Practical Science and the Water Department.

Respectfully submitted.

EDMUND B. WESTON,
M. Am. Soc. C.E., M. Inst. C.E.

PROVIDENCE, March 6th, 1893.

RECORDS OF NEW ENGINE FROM JANUARY 18TH, 1893, TO MARCH 26TH, 1893.

ENGINEER'S LOG.—ENGINE NO. 4.

Pressure taken from Edison Recording Gauge Chart, Toronto Water Works—Main Pumping Station.

Date.	Revs.	Hours Run.	Imperial Gallons Pumped.	Coal.	Coal per hour.	Water lb. Coal.	Height.	Duty.
				lbs.	lbs.			
Jan. 18	49,089	24	10,357,799	23,400	975	442.6	241	106.6
" 19	49,243	24	10,390,273	24,154	1,006	430.1	244	104.9
" 20	49,503	24	10,445,133	21,763	907	479.9	243	116.6
" 21	49,497	24	10,443,867	21,020	876	496.7	245	121.7
" 22	36,224	$18\frac{10}{60}$	7,643,264	16,340	908	467.7	238	111.3
" 23	49,136	24	10,367,696	22,248	927	470.5	236	109.9
" 24	50,073	24	10,565,403	21,385	887.5	494	336	111.9
" 25	49,531	24	10,451,041	21,311	879.6	490.3	238	116.7
" 26	51,461	24	10,858,271	22,639	943.7	479.6	242	116
" 27	51,168	24	11,796,448	21,914	913	492.7	246	121.1
" 29	36,966	$17\frac{50}{60}$	7,799,826	14 688	822	531	238	126.3
" 30	50,156	24	10.582,916	22,032	918	480.3	248	119.1
" 31	50,478	24	10,560,858	23,664	986	450	246	110.7
Feb. 1	49,890	24	10,526,790	18,768	782	560.8	218	122.2
" 2	51,682	24	10,904,902	19,584	816	536	211	117.4
" 3	51,488	24	10,863,968	19,394	808	560	213	119.3
" 4	51,715	24	10,911,865	20,590	858	529.9	226	119.7
" 5	52,207	24	11,015,677	26,370	1,095	417.7	242	$101\frac{60}{100}$
" 6	40,153	18	8,472,283	22,230	1,095	379.4	245	93.3
" 7	43,977	20	9,279,147	20,488	1,024	452.9	242	109.6
" 8	54,453	24	11,489,583	22,823	951	503.4	236	118.8
" 9	56,376	24	11,895,336	24,003	1,000	495.5	227	112.4
" 10	53,934	24	11,380,074	25,342	1,056	449	243	109.1
" 11	44,358	$19\frac{35}{60}$	9,359,538	20,436	1,075	457.9	224	102.5
" 12	55,269	24	11,661,759	25,120	1,047	464.2	243	112.8
" 13	55,233	24	11,654,136	25,120	1,047	463.9	238	110.4
" 18	112,838	$49\frac{30}{60}$	23,808,818	50,413	1,028.8	471.8	240	110.5
" 19	47,944	21	10,116,184	26,000	1,083	389	237	92.2
" 20	53,580	24	11,305,380	24,000	1,000	471	233	109.8
" 21	52,254	24	11,025,594	21,141	880	521	224	116.8
" 22	52,056	24	10,983,816	21,896	912	501.6	236	118.3
" 23	52,107	24	10,994,577	21,8 6	912	502	236	118.4
" 24	52,557	24	11,089,527	22,649	943.7	489.6	239	117
" 25	52,664	24	11,112,104	22,799	949.9	487.3	235	114.5
" 26	52,158	24	11,005,338	24,242	1,010	454	243	110.4
" 27	52,441	24	11,065,051	25,706	1,070	430.5	238	102.4
" 28	52,007	24	10,973,447	25,024	1,042	438.9	239	104.8
Mar. 1	51,919	24	10,973,477	23,340	972.5	469	243	114
" 4	41,964	19	8,854,404	20,176	1,062	434	242	106.2
" 5	52,692	24	11,118,012	23,280	970	477.5	242	115.5
" 6	52,796	24	11,139,956	24,832	1,034.6	448	238	106.7
" 7	52,101	24	10,993,311	24,025	1,001	457.5	244	111.6
" 8	52,056	24	10,983,816	24,025	1,001	457	241	110.1
" 9	51,910	24	10,953,010	24,768	1,032	442.2	243	107.45
" 10	52,288	24	11,032,768	24,025	1,001	459.2	243	111.13
" 11	44,897	$21\frac{35}{60}$	9,473,267	20,150	937	420.5	234	110.01
" 12	50,039	24	10,558,229	23,220	967.5	454.7	244	110.94
" 13	35,357	$16\frac{40}{60}$	7,460,327	15,480	939	481.9	241	116.14
" 14	12,317	$5\frac{30}{60}$	2,598,887	4,650	775	558	237	132.4
" 15	34,063	16	7,187,293	14,725	920.3	488.1	239	116.6
" 16	48,108	24	10,150,788	20,176	840.7	503.1	227	114.2
" 17	50,238	24	10,600,218	23,280	970	455.3	240	109.2
" 18	48,464	24	10,225,904	21,728	905.3	470.6	229	107.77
" 19	50,030	24	10,556,330	20,952	873	503.8	239	120.41
" 20	49,587	24	10,462,857	20,952	873	499.3	239	119.35
" 21	49,493	24	10,443,023	22,562	940	462.8	237	109.69
" 22	49,507	24	10,445,977	18,624	776	560.8	213	119.46
" 23	50,789	24	10,716,479	20,952	873	511.4	230	112.86
" 24	43,151	$20\frac{20}{60}$	9,104,861	18,624	931	488.8	244	117.52
" 25	31,091	$14\frac{55}{60}$	6,560,201	13,590	962	470.2	240	112.86
" 26	40,664	$18\frac{25}{60}$	8,580,104	20,124	1,087.8	426.3	247	105.31
Average	3,011,387	$1,400\frac{17}{10}$	635,402,657	1,341,206	958	$473\frac{754}{1000}$	$237\frac{18}{100}$	112,357,760

Average duty for sixty-one days, 112,357,760.


STATION
ROAD BETWEEN THIRD AND FOURTH CONCESSIONS
EGLINGTON
DUFFERIN
OSSINGTON AVE.
BATHURST
AVENUE RD.
DAVISVILLE RD.
BELT LINE
UPPER CANADA COLLEGE
CLINTON AV.
MOUNT PLEASANT CEMETERY
DEER PARK
CARLTON VILLAGE
THIRD CON ROAD ON ST CLAIR AVE
STATION
DAVENPORT STATE
JUNCTION
Reservior
ROSE HILL RESERVOIR
C P RY
CITY LIMIT
CANADA PACIFIC
VAN HORNE AV
VERMONT
DOVERCOURT
DELAWARE
STATION VILLAGE
ROSEDALE
2nd Con From Bay
1st Con From Bay
HIGH PARK
WEST CITY LIMIT
CRUSADERS 1939
PARKDALE
LUNATIC ASYLUM
QUEENS COLLEGE
PARK
GENERAL
MEDICINE
38
37
36

EGLINGTON AVE.

DAVISVILLE P.O.

AVENUE RD.

UPPER CANADA COLLEGE

CLINTON AV.

AVENUE RD.

BELT LINE

MOUNT PLEASANT CEMETERY

DEER PARK

EAST YORK AV.

C.P.R.

POND

THIRD CON. FROM BAY OR ST CLAIR AVE

Reservoir

N. CITY LIMIT

ROSE HILL RESERVOIR

C.P.R.

Clergy Reserve

Con 2 From Bay

ROSEDALE

DANFORTH AVE

Weber's Hotel

G.T.R.

G.T.R. FREIGHT YARD

LAKEVIEW AV.

EAST TORONTO

DAWES RD

LANSDOWNE

Con 1 From Bay

RIVERDALE

CITY LIMIT

KINGSTON ROAD

NORWAY

Duggan's Hotel

RACE COURSE

HUMBER BAY

TORONTO HARBOUR

1st Con from Bay

WEST CITY LIMIT

HIGH PARK

GREENLEES POND

PARLIAMENT

LUNATIC ASYLUM

CENTRAL PRISON

EMIGRANT SHEDS

EXHIBITION GROUNDS

NEW GARRISON

QUEEN'S PARK

UNIVERSITY COLLEGE

TRINITY COLLEGE

MAGNETIC OBSERVATORY

PARLIAMENT BUILDINGS

OSGOODE HALL

NORTHERN & PASSENGER DEPOT

G.T.R.

C.P.R.

REFERENCE

Cedar Block Pav^t colored thus.....

Trinidad Sheet Asphalte.....

Stone Block and Scoria.....

Macadam.....

Brick.....

Unimproved Roadways.....

PLAN

OF THE

CITY OF TORONTO.

SCALE

1000 2000 3000 4000 Feet.

LAGOON

MARLAIS POINT

BLOCK HOUSE BAY

REID'S WHARF

WIMAN & GRATHS

LIGHT HOUSE

LIGHT HOUSE POINT

City Engineers Office,
Toronto.

M-109
60 INCH


mm 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
INCHES 1 2 3 4 5 6
12 11 10 9 8 7 6